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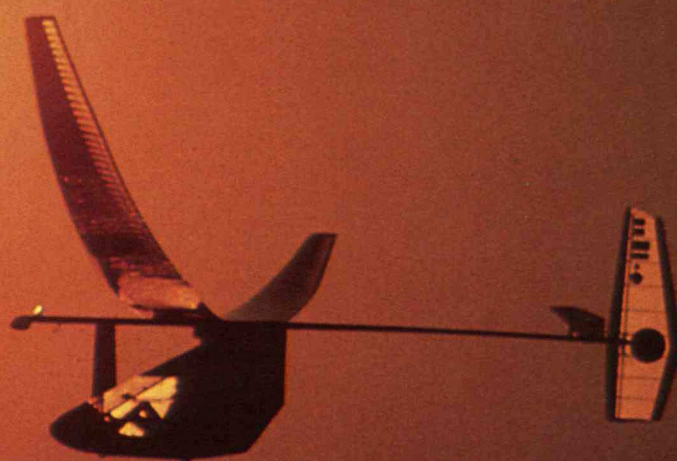
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TechnologyReview

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OCTOBER 1988

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DAEDALUS

TECHNOLOGY RECREATES A LEGEND

By John Langford
Daedalus Project Manager



technology review

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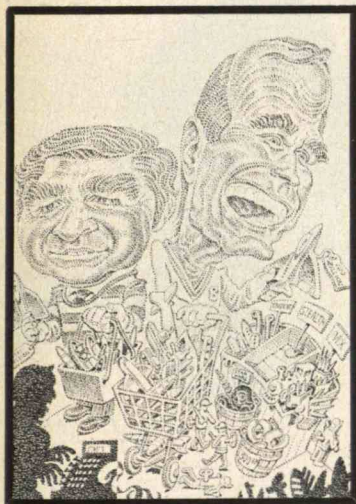
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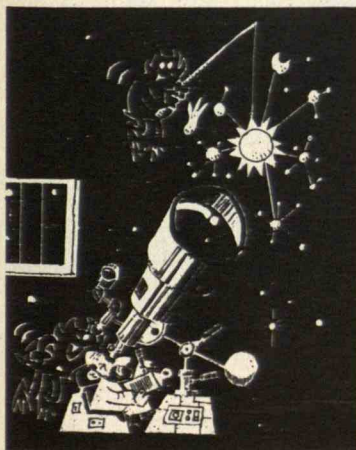
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EDITOR EMERITUS

John I. Mattill

FIRST LINE

FROM THE EDITOR

Passing the Baton

WHAT I remember most clearly about Jonathan Schlefer's arrival at *Technology Review* in the summer of 1982 is the unusual background he brought: a bachelor's degree in classics and mathematics from Harvard College, a master's degree in architecture from the University of California at Berkeley, and quite a lot of journalism experience, including architectural criticism and contributions on social, political, and technological issues as a writer for the *Real Paper* and the *Boston Globe*.

Since then, Jonathan's presence at the *Review* has been characterized by quality thinking, hard work, a high level of achievement, and a low level of noise, making his contributions nearly anonymous—and highly effective. One of the best changes we made in recent years was to promote him managing editor in 1985. At that time, I credited Jonathan in this space with both “great insight into the issues that motivate *Technology Review*” and “a lively sense of how a magazine should work.”

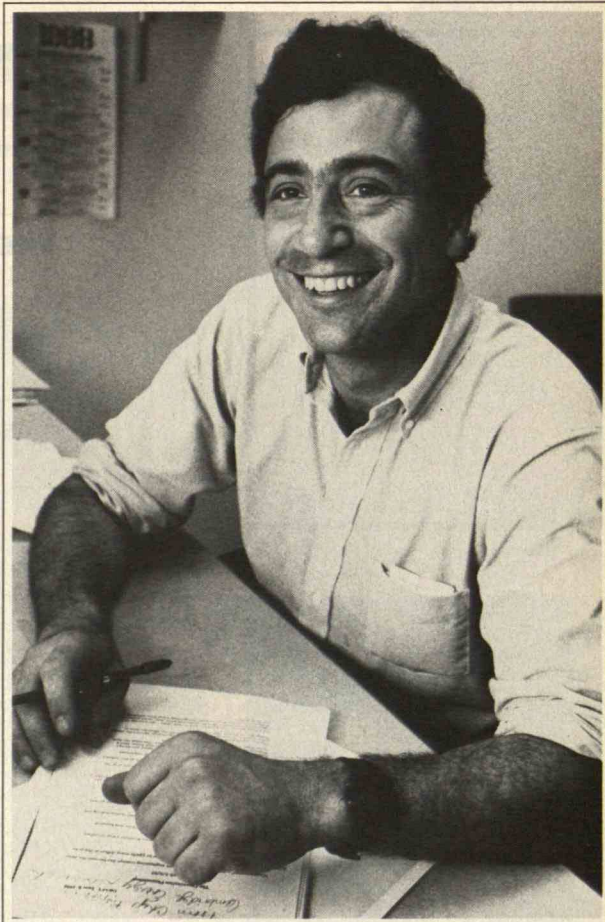
Now I report with pride—and, I readily admit, with a few qualms on my own behalf but none for the magazine—that Jonathan Schlefer is the new editor-in-chief of the *Review*, the 13th to hold that responsibility since our founding in 1899. Since becoming managing editor, Jonathan has gradually taken increasing responsibility for the *Review*'s content and he is clearly the choice of his colleagues.

In anticipating Jonathan's influence, readers need not brace themselves for radical change. They may look forward with

confidence, however, to continuation of improvements reflected in recent volumes.

As editor emeritus, I shall cherish continued association with Jonathan and his colleagues as an advisor and occasional contributor. Indeed, I would not have it otherwise; and readers may take this as the strongest statement I could make of my confidence in the agenda that *Technology Review* sets for itself and its ability to fulfill that agenda under its new editor's leadership.

John I. Mattill



Jonathan Schlefer



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CHARLES PANATI

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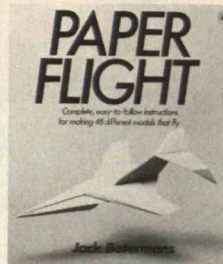
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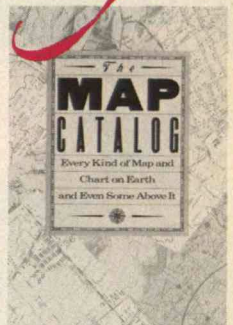
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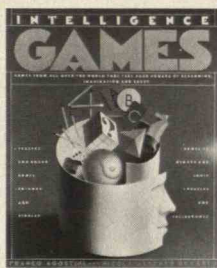
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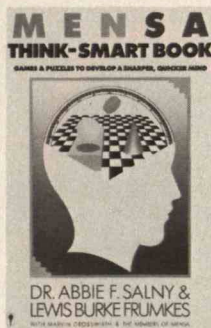
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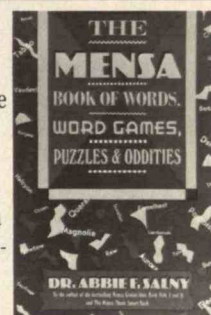
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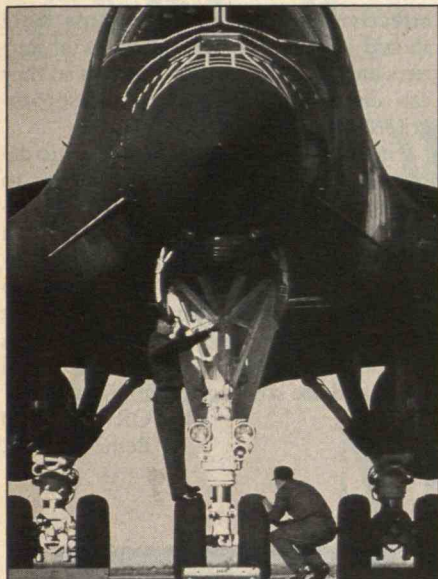
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The Politics of Acquiring Weapons



B-1 BLUES

I was disappointed that such a prestigious publication as *Technology Review* would include the poorly researched article "Money, Politics, and the B-1 Bomber" by Nick Kotz (April 1988). If the author had structured his examination of the B-1 bomber as a case study in weapons acquisition, then some credibility might have attended it. Instead, Mr. Kotz's tirade against the B-1, which he extends to argue against aircraft carriers and helicopters, lies somewhere between irrationality and disinformation.

Mr. Kotz is right when he notes that the political and economic interests of many actors—the president, the Congress, the armed services, and the public—affect the weapons-acquisition process. But he is dead wrong when he contends that the national military strategy lacks coherence, that there has been a "mindless acceleration" of the arms race, that there has been a "30-year defense buildup," or that the "military program is out of control."

Over the last 30 years the United States has constructed a coherent, credible, and successful strategy of deterrence underwritten by the capable forces of the triad. President Reagan's decision to procure 100 B-1 bombers was a prudent one: manned bombers will become increasingly important as arms negotiators seek to reduce intermediate- and longer-range nuclear missiles.

The procurement of the first strategic bomber in 30 years has entailed substantial costs, but no program costs have ever

been more closely controlled than those of the B-1. Moreover, despite substantial increases in Soviet defense budgets over those years, the portion of the GNP that the United States spends on defense is now 25 percent less than it was in the early 1960s. Strategic nuclear forces, including the highly capable B-1 bomber, comprise 8 percent of the defense budget, which would seem to be a prudent minimum investment in deterrence, and in national security.

LARRY D. WELCH
Washington, D.C.

Larry D. Welch is chief of staff of the U.S. Air Force.

I regret the unsupported assertions by Nick Kotz that the B-1 bomber is a "flying Edsel" and that it is an example of how "special interests have grossly distorted defense priorities and needlessly exacerbated the arms race."

In fact, the B-1 bomber is an excellent airplane that will perform the missions, both nuclear and conventional, for which it was built. I know this to be the case because as director of NASA-Ames Research Center from 1969 to 1977, I was heavily involved in the supervision of the wind-tunnel tests, theoretical analyses, and flight simulations that led to the final configuration of the airplane. I know the data in detail, and I worked hard to help develop the aerodynamics and the handling qualities that make the B-1 such a superb flying machine.

We who backed the B-1 program did so for the most obvious of reasons—which is that we believed the United States needed it. *Technology Review* readers must remember the atmosphere in the late 1970s. While the B-1 production program was suspended and the MX missile program was languishing, the Russians were deploying heavy intercontinental ballistic missiles—the SS-18s. They were also building several hundred Backfire bombers, and their Blackjack bomber was in the mockup and prototype phase. At the same time, they were invading Afghanistan. The Sandinistas, with Russian support, had established their regime in Nicaragua, and there were Russian incursions into Angola and Ethiopia.

Because of the B-1 bomber and the MX missile, the Russians fear us more than they did in the late 1970s, and they have pulled in their horns. Thus, Mr. Kotz is

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free to write about the "failures" of the military community—rather than damage done by Russian aggression.

HANS MARK
Austin, Tex.

Nick Kotz's article on the B-1 bomber is disturbing, but what is most disconcerting is the role of Hans Mark and Seymour Zeiberg, who had the technological expertise to have known better. Employees of Rockwell International and members of Congress whose districts were affected might have been expected to try to save the plane, but when presidential appointees deliberately thwart presidential decisions, it makes you wonder who is running the country. This kind of maneuvering has given us a military establishment with too many nuclear-powered aircraft carriers and not enough minesweepers, too many planes and not enough personnel. It has also given us helicopters that break down when we try to launch a hostage rescue mission.

ROBERT JOEL YAES
Lexington, Ky.

For *Technology Review* to print the piece by Nick Kotz without rebuttal is inappropriate. In fairness to Kotz, the B-1 has not been a perfect program. But his description of it and, worse, the cheap shots at other programs are typical of what appears in some of today's biased newspaper reporting. There are in fact many valuable, successful military programs that are serving the country well. Kotz probably has not heard of Poseidon and Trident, for example.

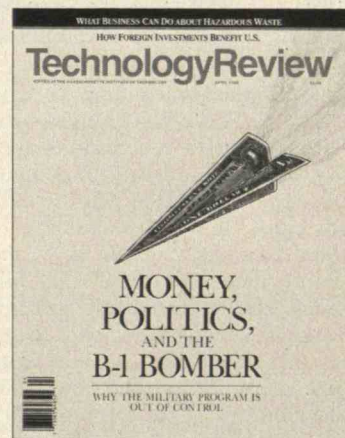
Moreover, it is highly improper to label patriotism as one of several negative qualities that have nothing to do with concern for the national good. And by including loyalty to an institution or idea in his classification of narrow self-interest, Kotz manifests his lack of respect for the military services and especially for the dedication to duty of the individuals who serve in them.

In criticizing U.S. weapons systems, Kotz singles out Navy carriers and Army helicopters for their "vulnerability." In a relative sense, both are vulnerable, but so is an aircraft in flight, and so is infantry on the battlefield. Nevertheless, carriers provide the best way to put Navy aircraft where it can perform all its intended missions, and helicopters are singularly suitable for putting infantry in the most

effective field position. Perhaps Kotz should explain the shortcomings of carriers and helicopters to the Soviets so they can discontinue their own intense programs to develop both.

Finally, in his swipe at the strategic defense initiative (SDI), Kotz alludes to "dozens of scientists and nuclear strategists" who he says are convinced such a system will not work. But many distinguished scientists also said the atom bomb could not be built. Furthermore, Kotz gives no credit whatsoever to the dozens of scientists who believe that SDI will work and are striving to see that it does.

VICTOR DELANO
Bethesda, Md.



I admired greatly the design and visual impact of your April 1988 cover on the B-1 bomber—especially when I realized that it is impossible to fold a dollar bill as depicted.

W.J. BROUGHTON
Ontario, Canada

INACCURATE WHISTLE-BLOWING
"Court Victory for Whistle-Blowers" by Christine Nichols (*April 1988*) examines a dispute between the Nuclear Regulatory Commission (NRC) and the Government Accountability Project (GAP). In essence, it depicts a courageous and determined GAP battling to force a reluctant NRC to investigate more than 600 allegations of
Continued on page 78

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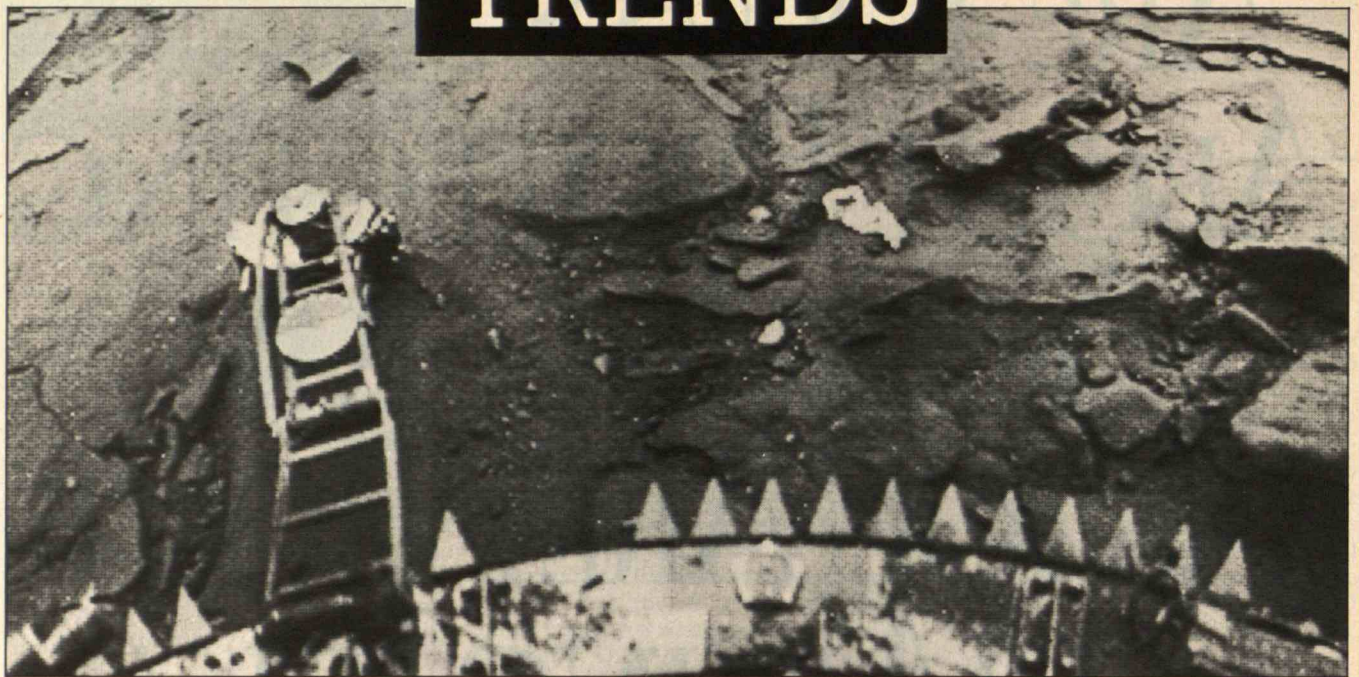
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TRENDS



The Venus Controversy

Jim Kasting wonders about the "Goldilocks" problem. Why is Mars too cold for life, Venus too hot, and Earth just right? The problem has implications for theories about how solar systems form, the evolution of life on planets, and even the future of Earth's oceans.

Kasting, an atmospheric scientist at NASA's Ames Research Center in Mountain View, Calif., is one of many who believe that Venus might have been "just right" 4 billion years ago when it was a newborn planet. Perhaps hot seas that could have borne life covered the young Venus.

But last December David H. Grinspoon, a University of Arizona at Tucson graduate student, wrote that there's no proof the terrestrial planets were once the same. According to Grinspoon's faculty advisor, John Lewis, "There's an attitudinal problem that Venus is Earth's twin." The debate has been heated ever since—with scientists on both sides calling their opponents' ideas "gross" and "biased," not to mention wrong.

The standard theory says

all three planets were formed from the same materials, explains George W. Wetherill, a planetary scientist at the Carnegie Institution of Washington, D.C. Before there were planets, there was the solar nebula, a rotating disk of gases and dust particles. The dust and pebbles collided and were held together by gravity. Over a few million years, the chunks fused into planetesimals, with diameters of about 50 to 100 miles. Planetesimals coalesced into protoplanets.

According to a computer model of planet formation Wetherill developed, the "proto" Earth and Venus attracted planetesimals from each other. "I would find it very difficult for Earth and Venus to have different chemical composition if they were formed from the same planetesimals," says Wetherill.

If the planets were formed from the same materials, then why does only Earth still have liquid water? Mars probably has a vast supply of water, but it is frozen. Venus is almost completely dehydrated.

In 1981, Kasting and his colleagues suggested that the young Venus did once have

vast oceans. Working with the University of Michigan's Thomas M. Donahue, they proposed that the golden planet's seas evaporated and its surface turned into an acidic cauldron because it was so close to the sun.

As proof, the team published data from a U.S. *Pioneer* Venus mission that studied the poisonous atmosphere of the cloud-covered planet in December 1978. As one of its probes plummeted though Venus's sulfuric-acid clouds, it found that the scant water in the atmosphere had a lot of deuterium, a heavy isotope of hydrogen. The ratio of deuterium to hydrogen was about 100 times greater than on Earth.

The deuterium is a remnant of Venus's ancient past, a "memory" of how much water there was, Donahue reasons. If Venus were born wet, some of the hydrogen in the water molecules would have been deuterium. Ultraviolet sunlight would have freed both hydrogen and deuterium, and much of the liberated hydrogen would have been lost to space. More of the heavier deuterium would

The Soviet Venera probe photographed Venus's parched surface, but scientists think oceans might once have covered the planet.

have stayed behind.

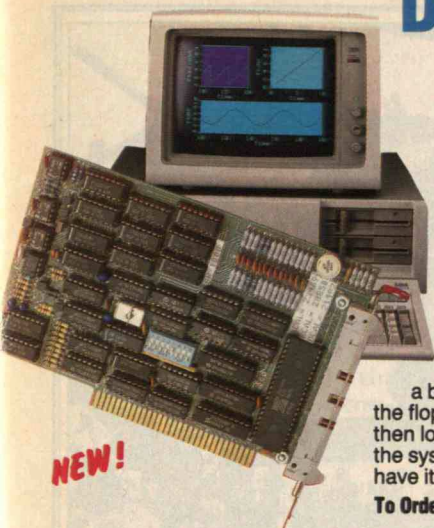
The controversy erupted with an article by Grinspoon in *Science*. "Botticelli depicted a watery birth of Venus, standing serenely on the shell of a giant clam," he wrote. "Planetologists have held a similar view of the birth of the love goddess's celestial counterpart. However, it may not have been so."

The Comet Theory

Grinspoon says the veneer of deuterium is not a sure-fire indicator of historic hydrogen. Lewis agrees and thinks the presence of the isotope "says absolutely nothing about oceans on Venus."

Grinspoon and Lewis say Venus could be supplied continuously with water—including hydrogen, deuterium, and oxygen—by an extraterrestrial source: comets. As these dirty "snowballs" slam into Venus, they could steadily replenish the planet's scant water.

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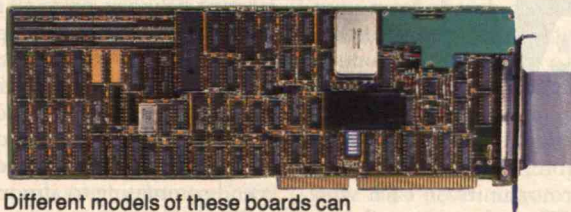
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If Grinspoon is right, it could force scientists to rethink the formation of the solar system. He insists the differences among the terrestrial planets—Earth, Venus, and Mars—have always been profound. He points to their different inventories of rare inert gases, such as argon, neon, and krypton. And the planets have different densities, prompting him to propose they formed from different parts of the solar nebula.

At a 1988 American Geophysical Union meeting, Donahue criticized Grinspoon's calculations. "I told him there were gross problems with his numbers," says Donahue. He says he told the Arizona researchers, "If you do your arithmetic right, you'll say comets are inadequate to explain the present water on Venus." Donahue thinks Grinspoon has overestimated the number of comets that would collide with Venus. He also believes the Venusian atmosphere today contains more water than Grinspoon and Lewis think it does.

The issue is clouded by what both sides admit are "peculiar" measurements taken by U.S. and Soviet spacecraft, which show different amounts of water vapor at various altitudes. Better data could come from NASA's *Magellan* Venus orbiter, scheduled for 1990.

M.I.T.'s Gordon Pettengill, principal investigator for *Magellan*, explains that wet-Venus advocates hope to spot evidence of shoreline erosion. "That's very far out, like finding life on Mars. We don't really expect to, but we'll look for it because it would be so fantastic." □

ANN GIBBONS is a science writer for the San Diego Tribune.



Hybrid Aircraft

A decade from now, air commuters may fly on a novel aircraft under development in both the United States and Europe. Called a tilt-rotor, it will have movable rotor units on each wing tip. When the rotors tilt vertically, the craft will fly sideways, hover, take off, or land like a helicopter. Tilting the rotors horizontally will transform the craft into an airplane.

Proponents argue that this hybrid offers an affordable solution to air-traffic congestion. LaGuardia, Kennedy, and Newark airports, serving New York City and New Jersey, "are near saturation point right now," says Al McDonough, Federal Aviation Administration (FAA) program manager for East Coast heliports. "Probably 50 percent of the traffic at those airports are for passengers going less than 350 miles."

One reason tilt-rotors may help alleviate the situation is that they can operate out of

existing heliports or small regional airports, as well as specially designed metropolitan or suburban "vertiports." They would be ideal for short air trips and could even decrease the time passengers spend commuting to airports.

Since tilt-rotors are part airplane, airlines and passengers may accept them more readily than redesigned helicopters. Conventional helicopters are expensive to maintain, noisy, and too slow to satisfy the potential market for alternative air transportation. A 1987 study, conducted by NASA, the FAA, and the Defense Department, argues that tilt-rotors would be far quieter than helicopters, perhaps even during lift-offs and landings. The study suggests that a commercial tilt-rotor could carry 75 commuters from downtown New York to downtown Washington at a speed of 300 miles per hour. The entire trip would take 40 minutes. And tilt-rotors would be far cheaper to maintain than heli-

In May the V-22, an airplane that can convert into a helicopter, rolled out of a Texas flight-test facility.

icopters, though more expensive than airplanes.

To take advantage of tilt-rotors, cities would construct downtown landing sites, equipped with advanced landing systems. The study estimates that a vertiport could cost between \$11 million and \$80 million, excluding the price of the site. By comparison, new metropolitan airports cost between \$4 billion and \$6 billion.

The FAA will have to certify the craft, a much longer—and therefore more expensive—task than approving new versions of existing craft. The FAA must also fashion discreet routes for tilt-rotor air traffic.

Which Market?

A commercial tilt-rotor is at least a decade away, but a military version already exists. A V-22 Osprey, constructed by Boeing Heli-

copters and Bell Helicopters Textron under contract to the U.S. Navy, will have its maiden flight this fall. Following several years of tests, the first V-22s will go to the Marines, probably in the early 1990s. The two companies reportedly invested \$90 million in V-22 development between 1982 and May 1986, when they received a \$1.81 billion contract for six flyable and three non-flyable prototypes.

Eventually, the Marines hope to get 552 tilt-rotors to replace their amphibious-assault helicopters. The Air Force wants 55 for special operations; the Navy will use 50 for air/sea rescue and is considering another 300 for anti-submarine warfare. The Army originally wanted 231 Ospreys, but backed out at least until 1994 because of budget constraints.

The V-22's body is fabricated almost entirely of solid-laminate graphite epoxy composites, and the rotors are advanced fiberglass structures. The craft will come with sophisticated electronic flight controls, similar to those in the new F-16 fighter. Equipped with a special fuel bladder, the V-22 could carry three people 2,100 miles with one-fourth the noise of a helicopter.

Since Bell and Boeing would be obliged to swallow costly overruns on V-22 production, the firms will probably not work on a commercial tilt-rotor at least until the mid-1990s. However, a consortium of aerospace and helicopter firms from France, West Germany, Spain, Italy, and Britain is more committed to a civilian project. They launched a tilt-rotor program last January and hope to sell a craft by the late 1990s, the earliest a U.S. version could be available.

Jacques Andres, a spokesman for Aerospatiale, a French firm in the consortium, says European governments will commit 50 to 60 percent of the program's funds to design and manufacture the tilt-rotor. Eurofar, as the venture is called, has already spent \$30 million on research. According to Andres, the European tilt-rotor will look similar to the Osprey and also be made of composite materials. In the Eurofar version, only the rotors and not the entire rotor cell will tilt.

The consortium plans to build a 30-passenger vehicle, which Andres says will serve a different market from the probably larger Bell and Boeing craft. "We see a potential market for 1,000 machines," Andres estimates.

Eurofar worries proponents of a U.S. civilian craft, including Rep. Tom Lewis (R-Fla.), a member of the House Committee on Science, Space, and Technology. Tilt-rotors could be a billion-dollar industry by the year 2000, and James Greene, an aide to Lewis, believes the first commercial product available will take the lion's share of the market.

Meanwhile, the Pentagon is bullish on the tilt-rotor. Advocates had worried that since most major military programs are under review, the \$23.7 billion price tag for the craft would make it an obvious target for Pentagon belt tightening. But the Defense Department's review staff decided in July to accelerate the program, not to cut it. While the final decision rests with Congress and the president, the Navy and the Marines look forward to an early delivery of V-22s. □

THOMAS KIELY is a frequent contributor to *Trends*.

Japan's Eco Rag

They say that 96 percent of the Japanese love nature, but it is a passive love. People aren't really concerned," observes Ichiro Kajiki, publisher of *Oikos*, the first general circulation magazine in Japan devoted to ecology.

Kajiki's lament is a familiar one. Japan, a nation that prides itself on a tradition of aesthetic appreciation of nature, has also garnered a reputation for disregarding the ecological consequences of development. Unfettered industrial growth caused a series of environmental disasters in the 1970s, and an aggressive anti-pollution movement emerged in response. But the movement subsided after the government enacted some of the world's toughest pollution standards, eliminating pollution's most visible evidence.

"An ethic of protecting nature has never taken hold in Japan," comments Kajiki, a graphic designer who founded *Oikos* with his wife, illustrator Nanami Kurasawa, in 1987. Named after the Greek root of "ecology," *Oikos* appears quarterly. Its circulation is limited—a lean 3,000—but it bravely proclaims itself "the magazine of

all life on earth."

"What we are trying to do," explains Kurasawa, who is editor, "is to introduce new ideas in ways that everyone can understand. We hope to broaden people's perspectives, to explore the ways we can change our own lives to make them more ecologically sound." The magazine is a potpourri of interviews with ecologists, snippets of information on topics like non-pasteurized milk, and special sections on subjects ranging from do-it-yourself solar-energy projects to the pollution of Tokyo Bay.

One of the first issues focused on whaling, which the magazine described as "a litmus test for Japan's international consciousness." Despite intense international pressure, Japan whaled until last year, when the International Whaling Commission banned the practice. Even then, taking advantage of a loophole that allows hunting for scientific research, ships continued to track down Antarctic minke whales and market the meat.

"Japanese whalers have mounted a successful [domestic] public-relations campaign that portrays the whaling ban as another example of Japan bashing," Kajiki notes. That

The Japanese publication *Oikos* calls itself "the magazine of all life on earth."





PLANT CRIES

At the University of California, Davis, biochemist Teresa Fan and environmental chemist Richard Higashi are listening to the radio signals of plants and marine animals that are under stress. The research, which is providing insights into the chemical processes that make life possible, could also improve studies of how pollutants affect organisms.

Fan and Higashi are using nuclear magnetic resonance (NMR) spectroscopy, long a tool for chemists interested in the structure of molecules and more recently a diagnostic tool in medicine. In one experiment, the Californians are tracking the biochemical reactions within the cells of two varieties of barley that tolerate salt differently. The results could help plant breeders design hardier crops by zeroing in on genes that code for high salt tolerance.

NMR instruments create energy shifts in atoms. Computer analyses of the distinctive radio signals these shifts yield can reveal chemical reactions that are occurring inside organisms.

BAY LIGHTS

The lights on San Francisco's Bay Bridge will soon be 75 percent more efficient. In 1986, to celebrate the bridge's fiftieth anniversary, 612 64-watt incandescent lamps were strung from the main suspension cables, outlining the bridge's entire three-mile span. The public liked the effect so much that officials decided to keep the lights—but the electricity has cost about \$1,000 a month.

Now those 612 bulbs are being replaced with nearly 1,700 compact fluorescents, which are much cheaper to operate. Manufacturers donated most of the equipment, and the rest was purchased at a deep discount. Pacific Gas and Electric also contributed to the upgrade, as did motorists who voluntarily chipped in quarters at toll booths.

POTHOLE PREVENTION

University of South Carolina civil engineers Ronald Baus and Richard Ray are waging war on potholes. Their project could reveal which roads need repaving and how much material is needed. "The bottom line is more efficient use of paving materials," says Baus, noting that his "state spends between \$25 million and \$30 million a year on resurfacing."

Currently, repair decisions are based "on a visual inspection and past experience," says Ray. He explains that the new system will detect "pavement that may not vis-

ually look distressed but may in fact be rapidly deteriorating."

Baus and Ray work out of a modified GMC Suburban camper that tows a 14-foot trailer containing 55-pound metal weights and a circular metal plate with sensors attached. The driver lowers the plate onto roads and drops weights onto it. The sensors measure the effect of the falling weights on the pavement, and with this information the engineers can calculate the highway's condition.

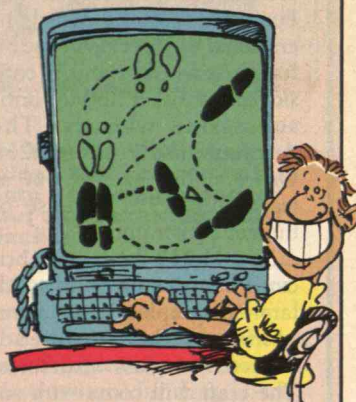
DANCE PHYSICS

Four years after the publication of *The Physics of Dance*, Kenneth Laws continues to apply his scientific training to ballet. In the book, the Dickinson College physicist examined solo dance. Now he is revealing how the same principles might help duos.

A student, teacher, and performer with the Central Pennsylvania Youth Ballet, Laws is researching one of the most common duo movements, the straight lift. He had expected the vertical force exerted by the man to lift the woman would be greatest when she is highest in the air. Not so. As a result, he says, a large force must be exerted inward on

her waist then. Otherwise, "it's hard to keep her from slipping through the hands." Moreover, since the vertical forces are greater when the woman is coming down, "the lifting partner must be especially conscious of his body position at that point in order to avoid injury."

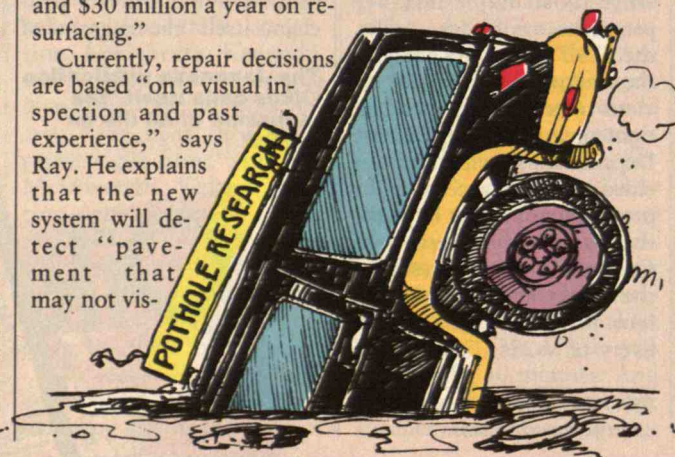
Laws videotapes dancers and measures their location frame by frame. Using a personal computer, he produces a graph showing how the force exerted by the lifting partner varies.



THE PIPERS PAY

Bagpipe players beware, warn Robert Hartenstein and Stephen Brittain. In a letter to the American Medical Association's *Archives of Otolaryngology*, the doctors say that the potential for temporary hearing loss or permanent ear damage from the Scottish instrument "is often ignored ... despite its considerable volume."

Hartenstein and Brittain measured sound levels during solo indoor and outdoor performances. In both cases, the levels reached 105 decibels at the piper's left ear. Outdoor levels hit 115 decibels inside part of the same ear. The maximum noise suggested by federal regulators is 105 decibels for an hour or 115 decibels for 15 minutes.



campaign has been so effective that the save-the-whales movement is virtually nonexistent. "There is strong resistance to not being able to eat whale," Kajiki says, even though such fare comprised less than 1 percent of the meat and fish in the Japanese diet before the ban. Traditionally a working-class food, whale is now a gourmet dish because it is scarce.

The plight of the Japanese river otter, another cause championed by *Oikos*, has received far less public attention. Once abundant in much of Japan, the river otter is on the verge of extinction, in large part because its coastal breeding grounds have been intensively developed. "The case of the river otter illustrates a fundamental problem," Kajiki suggests. "The Japanese see this as a choice between development and nature. We try to make the point that it is . . . a question of living together with animals."

Local Protest

The Japanese government defends its development policies by emphasizing Japan's lack of land and natural resources. Only occasionally have these policies been challenged, usually by regional opponents of specific projects. The summer 1988 issue of *Oikos* featured one such opponent, the village of Shiraho, which is protesting plans to build an airport on a coastal landfill.

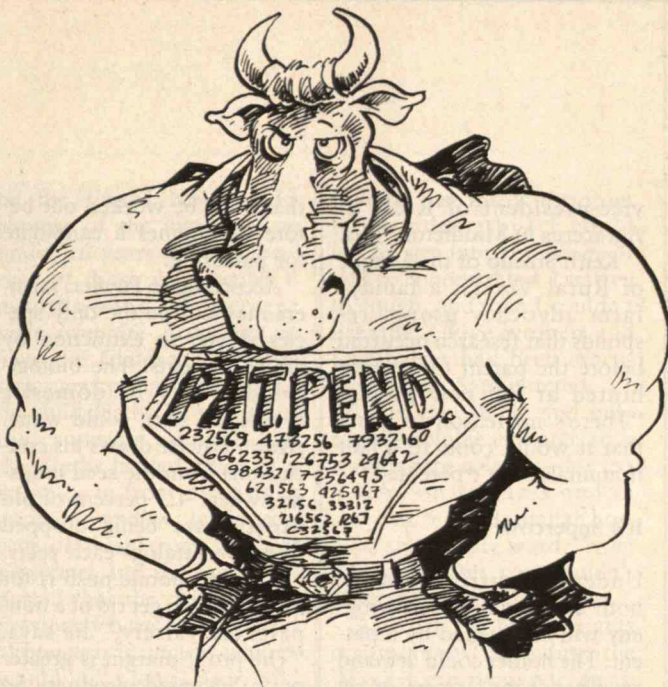
Shiraho is on Ishigaki island in the semitropical Okinawa archipelago, an area the government has targeted for tourism. To accommodate visitors, the government plans an airport large enough for Boeing 747s. However, the proposed site for the airport landfill encompasses a unique coral reef, one of the few healthy ones left in Okinawa.

The reef contains the only known stand of *Heliopora* coral north of the equator, along with 60 other coral species. In 1984, a reef survey was conducted by the Cousteau Society—Japan has no comparable organization dedicated to marine ecology—and Jacques Cousteau wrote a letter of opposition to Okinawa's governor. There was no response. This February, the International Union for the Conservation of Nature appealed for a halt to the project, but the government has only slightly modified construction plans.

The one issue that might transcend localism is nuclear energy. The Chernobyl accident drew attention to the fact that Japanese authorities have made no provision to evacuate people during an accident, and the industry has even deemed such plans unnecessary. But early in 1988, nuclear plants began tests at running at less than full level as a way to deal with excess capacity in Japan's electrical power system. This ignited opposition, since the Chernobyl accident occurred during the same kind of operation. Within weeks, over a million people signed petitions against the tests, and several large protests took place. Editor Kurasawa notes that the opposition to Japan's 36 nuclear power plants has been uncoordinated, and says, "We hope to build connections among these local movements."

She adds that some people think the questions *Oikos* poses put it 10 years ahead of its time. "The question is, how can we last that long?" □

JOHN JUNKERMAN, a Somerville, Mass., free-lance writer, has been reporting on Japan for over a decade.



Patented Animals

In April 1987, the U.S. Patent and Trademark Office stated its intention to "consider applications for patents on new types of animals produced by human intervention." One year later, a laboratory mouse carrying a gene that makes it more susceptible to cancer became the first animal to be patented. Crafted by Philip Leder at the Harvard Medical School and Timothy Stewart, now at Genentech in San Francisco, the mouse is designed to be ideal for testing cancer-causing substances.

The creature's utility notwithstanding, legislation calling for a two-year moratorium on animal patents is now pending in the Senate and the House. Over 30 representatives have asked for a temporary halt to animal patents, and several days of hearings held before the House Judiciary Committee last year fueled the legislators' caution. The hearings highlighted what the sponsors of the legislation call the "extraordinary economic, environmental, and ethical consequences" of the decision to

patent animals.

"While the new patent policy will affect almost every sector of the economy," Rep. Charlie Rose (D-N.C.) told the committee, the central concern is the potential impact on agriculture. "This new policy places major chemical, biotechnological, and pharmaceutical companies in the position to virtually take over animal husbandry in America," he charged.

Cary Fowler, program director for the Rural Advancement Fund in Pittsboro, N.C., says that patents attract a big corporation because they help ensure profits. He notes that concentration of ownership took place in the seed industry after the government approved seed patents under the Plant Variety Protection Act in 1970.

Corporations interested in developing genetically altered animals point out that better breeds wouldn't reach the market without such profit motivation. "If we don't have patents on animals, there's no incentive to put money into developing a more valuable animal," says Winston Brill,

vice-president of R&D at Agracetus in Middleton, Wis.

Keith Stroup of the League of Rural Voters, a family-farm advocacy group, responds that research occurred before the patent office even hinted at the new policy. "There's no reason to think that it would come to a halt if animals aren't patented."

It's Supercow!

Under the current system, both an animal and its progeny will be covered by a patent. The holder could demand royalties from farmers or set the conditions of sale on patented offspring.

"Simply collecting royalties would be an administrative nightmare," says Tom Cook, director of industry affairs for the National Cattleman's Association. Moreover, one patent per animal is the least complicated scenario. Since genes could also be patented, cows could come with a list of patents.

Stroup contends that the United States faces a choice between "adopting a system that either includes family farmers or turns the industry over to half a dozen corporations." It's just a matter of time, he says, before the first superpig or supercow is patented. Such a superanimal is likely to be a good deal more expensive than traditional breeds, possibly too expensive for small farmers. It would yield more product, cutting the cost of production in the long run, but only for farmers who could afford the initial expenditure. Department of Agriculture scientists in Beltsville, Md., have already made a leaner pig by fitting it with a cow's growth-hormone gene. However, the crossed eyes and arthritic legs of this rust-colored hybrid are just two of many problems

that must be worked out before it becomes a candidate for patenting.

According to Fowler, farmers may not be the only species driven to extinction by animal patents. The biological diversity of domestic breeds, he says, could wane. Again, Fowler draws his conclusions from the seed industry, where 4.5 percent of old varieties are being dropped from the catalogs each year.

"The economic push is for a company to get rid of a non-patented variety," he says. "The profit margin is greater on a patented product. So without a program to preserve existing species, patenting is actually a catalyst to extinctions."

Widespread uniformity among domestic species would increase the chances of a single disease sweeping an animal population. "Raising the uniformity of the gene pool increases the chances that whole herds will be wiped out," says Susan Shen, an Office of Technology Assessment specialist on species diversity.

Considering these ecological and economical threats, the patent office's decision to issue animal patents might appear hasty. However, the agency says it only made a legal decision based on a 1980 U.S. Supreme Court ruling that Congress intended patents to cover "anything under the sun made by man." Moreover, the patent office agrees that Congress should decide the ethics of the matter.

In the meantime, 30 animal patent applications awaited approval at last count. All signs indicate that the patent office will continue issuing its stamp of approval unless Congress orders a halt. □

SHAWNA VOGEL is an associate editor at Discover magazine.



Not Tears Alone

Tear gases are generally thought to be unpleasant but harmless, and until recently experts considered o-chlorobenzylidene malonitrile, popularly known as CS, to be no exception.

However, CS has now come under international criticism. Palestinian civilians, doctors, and officials have charged that the Israeli army has misused it in the West Bank and Gaza Strip, causing scores of civilian deaths, miscarriages, and other injuries.

Israeli officials contend that these claims are unsubstantiated. "We have not seen any cases where it could be proven by a coroner that anybody has been killed due to

exposure to tear gas," Brig. Gen. Yehuda Danon, the Israeli army's surgeon general, told the *Washington Post*. "And we have no scientific evidence that there have been more miscarriages following the use of [CS]."

The controversy swells a debate over the potential long-term effects of CS. In a report last year on the use of the gas against South Korean student dissidents, the Boston-based Physicians for Human Rights (PHR) urged a ban on it. PHR executive director Jonathan Fine says, "It's a misnomer to call CS 'tear gas.' In my opinion it's really poison gas."

CS takes its name from Ben Corson and Roger Stoughton,

In February, Israeli border police in Jerusalem fired tear gas after Palestinians threw stones at them.

who first prepared it in 1928. Although called a gas, it is actually a solid that is mixed with a pyrotechnic base and then exploded or sprayed by means of compressed air or other forms of pressure. Victims cough, tear, retch, and sometimes vomit. Their eyelids close, and they feel pain in their eyes and nose. *Human Toxicology* describes cs as "about 10 times more potent than CN [another tear gas]... but significantly less toxic." Because cs is not deadly in open spaces, it is popular with governments acting against street demonstrations. *Riot Control—Materiel and Techniques* by Col. Rex Applegate terms it "a nonlethal riot-control weapon."

The U.S. Army began preparing cs in 1959 for combat training and riot control. It has been widely used ever since—by various South Vietnamese regimes in the 1960s against Buddhist monks; by the British in Northern Ireland; and against Palestinians since January.

However, U.S. military and police literature warns against firing cs near hospitals, schools, nursing homes, and similar institutions. It is not meant to be used indoors or in semi-enclosed spaces. Cannisters from the gas's U.S. manufacturer, Federal Laboratories of Saltsburg, Pa., read, "WARNING. FOR OUTDOOR USE ONLY. NOT TO BE FIRED DIRECTLY AT PERSONS OR INJURY MAY RESULT." A Swiss journal says the gas "qualifies as a potentially dangerous substance" that can cause serious health complications in high and "uneven" concentrations—for

instance, if it builds up in small courtyards and alleys.

Infants and Elders

According to officials working for the U.N. Relief and Works Agency (UNRWA) in Palestinian refugee camps—including Dr. Samir Badri, UNRWA's chief health officer in the Gaza Strip—cs caused over 1,200 injuries, dozens of miscarriages, and at least 11 deaths between December and May. The United Nations estimates 44 cs-related deaths from December through June. Health officials and civilians charge that soldiers have frequently fired the gas into houses, courtyards, stores, and clinics.

The state of virtual warfare in the West Bank and Gaza since December complicates the task of compiling accurate statistics on such claims. This is particularly true of miscarriages, because no comprehensive baseline data exist. And medical journals contain almost no references to fetal deaths, perhaps because cs has rarely been used so pervasively against civilians.

It is clear that cs in high concentrations has killed laboratory animals. Autopsies have indicated that the animals died from hemorrhages and accumulated fluid in their lungs. Medical literature documents at least two human deaths; the victims had similar lung damage. The Physicians for Human Rights report on South Korea states that cs "can, in some cases, result in pneumonia, pulmonary edema (accumulation of fluid in the lungs), heart failure, and liver damage."

PHR stresses that, like all noxious chemicals, cs is particularly risky for hospitalized patients, children, elders, and the chronically ill. In the 44 cs-related deaths estimated

by the United Nations, 55 percent of the victims were under 16 years old—88 percent of those were under 6 months—and 18 percent were over 66. According to Save the Children, a voluntary agency that has studied the child deaths, 75 percent of the cannisters implicated in the deaths landed either in a house or in front of an open door or window. In 79 percent of these cases, medical personnel and the family reported that the children had previously been healthy. And although it is unclear why cs would kill a fetus, Badri told the *Washington Post*, "When you see a woman with no previous history of miscarriages or bleeding, and after exposure to tear gas she bleeds and aborts, you can safely say it is the gas."

Dr. Issa Satti, director and chief surgeon at Ramallah Hospital in the West Bank, says that soldiers fired two cs cannisters into the maternity recovery ward, despite the warnings on them. "I thought

I would just throw them out the window, but I could hardly get into the room. It was so concentrated. I started to cough, and then I couldn't breathe." Five women and four babies had been evacuated before Satti entered.

cs is very stable and only slightly soluble in water, so it stays where it lands—for example, on surfaces and in crevices. In the Ramallah hospital's maternity ward, "even 24 hours later you couldn't enter the room," says Satti.

A variety of human-rights organizations, including the Washington-based Arab Anti-Discrimination Committee, has publicly protested the use of cs gas. As a result, Federal Laboratories has not sent cs to Israel since May. However, Burl Alison, vice-president of Trans-Technology Corp. (Federal's parent company) will not say the company has suspended sales: "The State Department has approved shipments of tear gas to Israel, and we support that stand." □

Two Palestinian youths hurl stones as an Israeli army tear-gas cannister explodes nearby.

ELLEN CANTAROW has long reported on the Mideast for the *Village Voice*, *Mother Jones*, and other publications.



Liberating Technologies

During the recent political unrest in Panama, one particular story captured my attention. A group of Panamanian expatriates living in Washington, D.C., avoided the Noriega government's press restrictions by sending censored news reports to their homeland via telefax. The articles arrived at business offices in Panama City and then were transmitted to churches, schools, and labor union headquarters. From there, opponents of the regime distributed the information to large numbers of people throughout the country. According to one leader of the enterprise, the process represented "death to dictators, because what can they do to stop transmission?"

Long feared as a sinister tool in the hands of tyrants, today's technology is proving instead to be a champion of liberty. The telefax is merely one of the latest instruments of liberation available to oppressed peoples. For 500 years, the printing press has been a fundamental component of democracy. Today, the products of the electronic revolution are facilitating communication to a degree never seen before and in ways that are extremely difficult to repress.

Breaking the Monopoly on Information

Examples of technology's role in the worldwide battle for freedom of information are legion. The downfall of the shah of Iran was due in part to the simple tape recorder. Messages from the Ayatollah Khomeini were taped at his exile headquarters outside Paris, smuggled into Iran, copied and recopied, and distributed by the thousands. In the Iran of today, movies banned by the fundamentalist Islamic government are widely disseminated on videocassette tapes.

During the heavily contested 1986 election between then-president Ferdinand Marcos and Corazon Aquino in the Philippines, an independent poll-watcher's group used computer disks encoded with original voting results as potential evidence against later tampering by supporters of the Marcos regime.

In the Soviet Union, the "alternative press" has started to make use of desktop publish-



*New
communications
technologies are expanding
freedom of information
around the
world.*

ing. Lev Timofeyev, the editor of *Referendum*, an unofficial opinion magazine, has a Toshiba 1000 personal computer and a Kodak Diconix printer, purchased by friends at a Moscow second-hand store. "Modern technology will spread and come into its own," says Timofeyev. "The authorities already are losing control over the spread of information."

In the United States, the new technologies are also having a beneficial effect. Recently, critics have deplored what they see as a growing concentration of the American media. And yet, the enormous expansion of cable television, electronic publishing, and networking through computer modems is helping to disperse the vaunted power of the press.

Admittedly, the propaganda tools avail-

able to authoritarian leaders remain formidable. And it need hardly be said that the new technologies of communication won't automatically bring about a golden age.

Indeed, the electronic revolution confronts us with many new difficulties. For one, great vigilance will be required to ensure that the electronic systems we put in place are maintained and protected. Having a global information network will prove small comfort if everything hinges on a few satellites controlled by unaccountable political and economic organizations. And we dare not let the manufacture and distribution of crucial elements—microchips, for example—be dominated by any particular nation or group. Security, redundancy, maintenance, and continued availability of information technology to all—these must be our constant concerns in the era of the open world community.

There are also new threats to freedom inherent in increasing technological sophistication: electronic eavesdropping, computer analysis of individuals' habits, aerial photo analysis, mind-altering drugs, and so forth. The dangers stemming from Big Brother do not disappear just because the hazards of thought control are found to have been overstated. And the dangers to Big Brother—the predicaments of governments confronted with technically sophisticated criminals and terrorists—are ever more daunting.

The Genie in the Bottle

Finally, in our daily lives, how will we cope with the new capabilities provided by technology? What will we do with our increasing freedoms? Do we want to make use of electronic polls that can reveal instantaneously how every citizen feels about any given issue? How much pure democracy can we absorb? Should we tolerate automatic telephone-dialing devices that, according to the Direct Market Association, already reach more than 7 million Americans daily? If not, how and by whom are they to be controlled?

We have often thought of technology as a fairytale monster that, once created, might control and destroy us. A more apt parable is that of the genie in the bottle. After being released, the genie neither threatens nor constrains, but rather offers to fulfill wishes. And the moral of many a fairytale is that, when people are offered their heart's desire, they often make wishes they live to regret. Technology, like the genie, confronts us not with slavery, but with something nearly as vexatious: freedom of choice. □



SAMUEL C. FLORMAN, A CIVIL ENGINEER, IS THE AUTHOR OF *ENGINEERING AND THE LIBERAL ARTS*, *THE EXISTENTIAL PLEASURES OF ENGINEERING*, *BLAMING TECHNOLOGY*, AND *THE CIVILIZED ENGINEER*.



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The Great U-Turn

Ever since the Second World War put an end to the Great Depression, Americans have assumed that prosperity and economic equality were on the rise. And indeed, during much of the postwar era, they were.

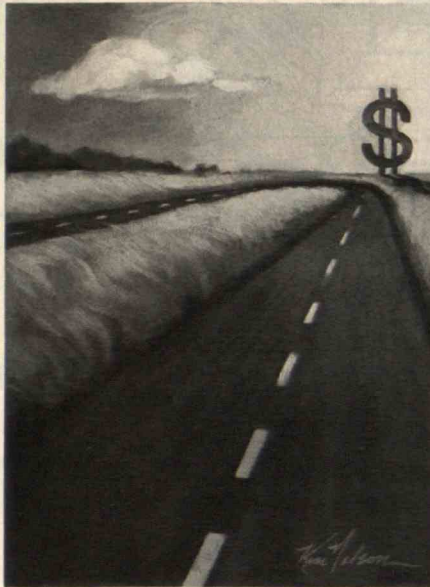
But during the past decade, this trend has taken a sharp U-turn. Average real family incomes have stagnated; average wages have declined; and the distribution of income, earnings, and wealth has become increasingly unequal. Even middle-class families are feeling the impact—more than at any time since the 1930s.

The Trend to Polarization

Consider the backbone of the U.S. labor force—workers who are employed year round and full time. This group includes few teenagers or elders, and consists disproportionately of people with families to support.

From the early 1960s to the late 1970s, the proportion of lowest-paid workers in this category—those with annual wages below \$11,000 measured in 1986 dollars—fell steadily from more than 20 percent to less than 14 percent. Since then, however, the percentage has grown. Of the new year-round, full-time jobs created between 1973 and 1979, two business-cycle peak years, about one in five paid wages this low. Since 1979, that proportion has nearly doubled to 36 percent. Meanwhile, the share of year-round, full-time workers at the other end of the wage spectrum, earning more than \$44,000 a year, has also grown, signaling increased inequality and economic polarization in U.S. society.

What is causing this U-turn? Not the overcrowding of the labor market produced by the baby boom, nor any special factors connected with sex, race, or particular sectors of the economy. The U-turn appears in the data for all age groups, for both men and women, for whites as well as workers of color, for services as well as manufacturing, and for all regions of the country. While the proliferation of low-wage employment is certainly more serious for the poorly educated, to some extent the U-turn even affects college graduates. Moreover, it has continued



The American dream of increasing equality has taken a turn for the worse.

right through the recent economic recovery, demonstrating that it is not purely a function of the business cycle.

Misguided Wage Cutting

Rather, the U-turn is the result of unique historical circumstances. In the late 1960s, full employment—largely due to government spending on the Vietnam War—and increased social regulation pushed wages up and put a squeeze on corporate profits. At the same time, unprecedented foreign competition forced U.S. firms to think twice about passing along their rising costs to customers in the form of higher prices.

Faced with the twin prods of higher costs and stronger competition, companies could have opted for the only sensible long-run so-

lution consistent with a rising standard of living: increasing productivity. Major investments in new technology, more constructive and cooperative labor-management relations, and the closer integration of market research and product design with actual production would all have helped. Indeed, during the same period our Japanese, German, Italian, and Scandinavian competitors were pursuing precisely such strategies.

Instead, more and more American corporations opted to restore profitability by cutting costs, especially labor costs. They declared wage freezes, demanded employee concessions, and introduced two-tiered payment schemes. They converted many full-time positions into part-time jobs and sub-contracted work to outside, generally lower-wage suppliers.

Government, both before and after the election of Ronald Reagan, added to the problem. Tight monetary policy created a deep recession, eroding workers' bargaining power still further. Rapid and poorly planned deregulation encouraged companies to seek short-term cost savings at the expense of long-term investment and growth. And anti-union policies at the White House and the National Labor Relations Board made it more difficult for unions to keep a floor under wages in order to protect workers' purchasing power.

Relearning an Old Truism

There's an old truism that American managers seem to have to relearn every 50 years: the wages they see as a "cost" are also the foundation of our country's standard of living. That's why economic strategies based on low-wage, export-led growth are fundamentally mistaken.

Because of the low cost of living in newly industrializing countries, U.S. wages can never be driven low enough to make our labor costs competitive. And without steadily rising wages, workers have no incentive to acquire the new skills or to participate in the labor-management dialogue on which improving productivity ultimately depends. Finally, at a time when debt-to-equity ratios are so high that lowering interest rates has little impact on corporate investment strategies, the best stimulus for investments in new product technology is the increased demand that better wages make possible.

For all these reasons, the U-turn is not only socially divisive but economically harmful. Stopping it is crucial to restarting the American economy. □



BENNETT HARRISON IS PROFESSOR OF POLITICAL ECONOMY AND PLANNING AT M.I.T. HIS NEW BOOK *THE GREAT U-TURN*, CO-AUTHORED WITH BARRY BLUESTONE, WILL BE PUBLISHED THIS MONTH.

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A new Kings-type allows a hard to swing door to be closed by a single person. The system consists of four "pop-it" buttons, one at each corner of the door. If pushed, the door is closed. The door is closed by a single person. The door is closed by a single person. (Licensor: Technology Transfer, Inc., 1000 N. 1st St., Suite 100, St. Paul, MN 55101. (612) 222-1111.)

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BY DAVID R. ZIMMERMAN

The Engineer's Role in Halting AIDS



WHEN a terrible cholera outbreak erupted in London in 1854, Dr. John Snow suspected that sewage was contaminating the district's drinking water and spreading the disease. When Snow found that cases were clustered around a water pump on Broad Street, he persuaded skeptical authorities to remove the pump handle, forcing residents to draw water elsewhere. The epidemic stopped as suddenly as it had started.

Today we are in a similar situation with AIDS. We need to isolate the narrowest and most vulnerable link of the disease's chain of transmission—and interrupt it. Nationwide, hypodermic needles used by drug addicts will soon be the main route for the spread of AIDS. In New York City and northern New Jersey, they already are. Before large percentages of addicts are infected in communities across the country, we should promote the development of needles that can be used only once, and induce or coerce addicts to use them.

This would be a simple solution to a complex problem, yet it has not been vigorously pursued. Until very recently, the

DAVID R. ZIMMERMAN is a free-lance journalist who writes about AIDS as it relates to public policy and science and technology.

Political
and moral biases
continue to forestall
technological efforts to
solve our most urgent
health problem.

federal government has refused to grasp the nettle and deal with AIDS' spread among addicts as a technical problem, on the grounds that to do so would be to condone drug abuse. Instead, Washington urges addicts to "Just say no!" Most can't, and there are too few treatment slots for addicts who wish to quit.

A few enlightened communities have bucked this political and moral agenda. Public agencies in San Francisco and some New Jersey communities distribute vials of household bleach to allow addicts to disinfect their "works." And a program in Portland, Ore., lets addicts exchange dirty needles for clean ones. Data reported at the Fourth International Conference on

AIDS, held in Stockholm in June, suggested that needle-exchange programs, in particular, slow the spread of the virus.

These epidemic control methods have picked the right target, the shared needle. But they leave too much to chance or choice among notoriously self-destructive people. An addict who really needs a fix will use any needle, clean or dirty. At this critical—and frequent—moment, addicts won't protect themselves, their lovers, or society at large from AIDS.

Needles that self-destruct after a single use would be a better solution. Yet in the report by the presidential commission on the epidemic, which contains hundreds of proposals for stepping up the war against AIDS, there is no demand that the government help develop such needles. Indeed, the concept is not even mentioned.

The private sector has been only a little less reticent about self-destruct needles. Representatives of two major medical instrument makers, Abbott Laboratories and Becton-Dickinson, say their biomedical engineers believe such needles can be made. But, they maintain, their companies are stumped by problems such as how to test-market and merchandise a product intended for illicit use. Becton-Dickinson also worries about how a self-destruct sy-

ringe could compete in price with the company's simple disposable syringe, which costs less than a dime wholesale.

These do not seem to be insurmountable obstacles. But the only people who appear not to be waiting for others to act are a few free-lance inventors. For example, San Diego physicist and psychologist Philip Kaushall has invented a self-destruct valve that he says can be built into the barrel or needle of a syringe. The valve allows a user to draw a drug up once through the needle and into the barrel. Injecting the drug permanently closes the valve, says Kaushall, who is reluctant to discuss more details until his device is patented and developed.

Meanwhile, Carl R. Sahi of Coventry, Conn., a chemist and former assistant medical examiner, has developed a syringe in which a thin, blunt-ended metal rod is automatically thrust down through the needle as an injection is finished. The rod, which will not penetrate the skin, locks in place about 0.02 of an inch past the needle

point, preventing reuse.

These individual efforts are poorly financed. But they and others like them support the view that the technological challenge can be met.

How could addicts be induced to use self-destruct needles? The most politically feasible solution could grow out of the safer needle designs being developed to protect health workers from accidental transmission of AIDS. These changes will be mandated under federal occupational safety laws. If the federal government stipulates that the safer needles should also self-destruct, AIDS transmission among addicts will drop as the more dangerous needles fall out of the market. Other simple answers also come to mind: self-destruct needles could be government subsidized and sold cheaply or given away, without a prescription.

The laws making it a criminal offense to carry a syringe without medical reason—common to many jurisdictions—

could be amended. Possession of a self-destruct needle could be made legal, while the penalty for carrying reusable equipment could be greatly toughened.

Our failure to seize a technological opportunity to combat AIDS transmission by needles raises an old question with new urgency: how can critical advances that are not obviously profitable be developed? We need laws to promote such work. The model could be the Orphan Drug Act, which offers incentives to develop drugs with markets too small to be profitable.

The more immediate issue is how the war against AIDS will be fought. Will the agenda be set by rational calculation? If so, the prospects are good, because the spread of the AIDS virus is governed by fathomable natural rules. Or will it be set by politics and morality? If that is the case, control efforts will fail—for humans respond to moral law inconsistently, viruses not at all. Technology's advocates can no longer afford to be silent. □

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DAEDA

A large, dark silhouette of the Aegean aircraft is the central focus, positioned against a vibrant, orange-hued sunset sky. The aircraft's unique design, featuring a high-wing configuration and a large, rounded fuselage, is clearly visible. Below the aircraft, the silhouettes of several team members are shown in various poses of celebration and effort. Some are standing with their arms raised in triumph, while others are working on the aircraft's structure. A ladder is also visible, leaning against the aircraft. The overall scene conveys a sense of achievement and teamwork.

ILUS

The Making of the Legend

BY JOHN S. LANGFORD

*The project manager
for the journey across the Aegean tells how
his team combined technology with
perseverance to achieve the record
for human-powered flight.*

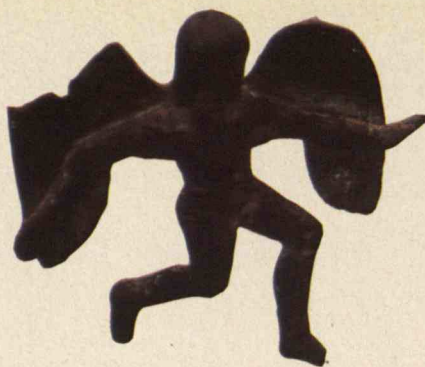
BEFORE us lies the dark water of the Aegean Sea and 72 miles of empty expanse. Behind us lie three years of planning, testing, and building. Tomorrow one of us will climb into a fragile 70-pound aircraft with diaphanous wings spanning 112 feet. With no energy except for the power of his legs, this pilot will take off in pursuit of the oldest dream in aviation: to fly northward from Crete to the island of Santorini.

Standing on the Venetian stone ramparts that frame the harbor of Heraklion in the settling dusk of this April evening, I watch the last fishing boats churn slowly back to port. Four kilometers away, a hangar made of steel tubes and nylon sits like a child's toy near the concrete bunkers of the Hellenic Air Force. Inside the zippered, tentlike door of the hangar sits the carbon fiber and plastic structure that will attempt the flight: *Daedalus*.

Centuries of human ambition hang on that name. This flight, like many others, was inspired by a Greek myth originating in the late Bronze Age and first recorded by Homer. According to legend, Daedalus, one of history's first engineers and an accomplished artisan and architect, was imprisoned on Crete. To escape, he built wings of feathers and wax or honey. His exuberant son Icarus, today the more famous of the two, ignored the father's admonitions and flew so high that the sun melted his wings. Though Icarus fell to his death, Daedalus flew on to safety.

This story shows that even 35 centuries ago people could imagine applying their minds and technology to

JOHN S. LANGFORD, now on the research staff of the Institute for Defense Analyses in Alexandria, Va., was the project manager for *Daedalus*. While a graduate student at M.I.T., he also directed the successful efforts to build two previous human-powered aircraft, *Chrysalis* and *Monarch*. He is co-writing a book about the recent project entitled *The Children of Daedalus* (Viking, 1989).



*Even 35 centuries
ago people could imagine
applying technology
to overcome physical
limits.*

overcome physical limits. It also illustrates humanity's tenuous relationship with technology. The tale has captured the imaginations of countless inventors who have tried to emulate their mythical progenitors, including Eilmer, an eleventh-century monk in Malmesbury, England, and Abul-Kasim Abbas in ninth-century Spain. Both leapt from heights with feathers attached to their arms, only to plunge to the earth below.

Now, in 1988, we hope to recreate the original legend and in the process fly farther under human power than any person has yet flown. The wakeup call goes out to pilot Kanellos Kanellopoulos, a 30-year-old Greek cycling champion, who arrives at the hangar at 5:30 a.m. (The only Greek member of the rotation of five pilots, he happens to be on call.) Having ridden more than 18,000 kilometers to train for this flight, Kan reports, "I am ready to go."

M.I.T. professor Mark Drela, the project's chief aerodynamicist, assists Kan into the cockpit. They check the controls and the security of the four bottles containing a special drink that will serve as Kan's coolant and fuel. "Have fun," says Mark as he seals Kan in. The entrance hatch is covered with Mylar, sealed, and shrunk tight with a heat gun.

In a few moments, the weight of the entire project will fall onto Kan's shoulders. But first Steven Bussolari,

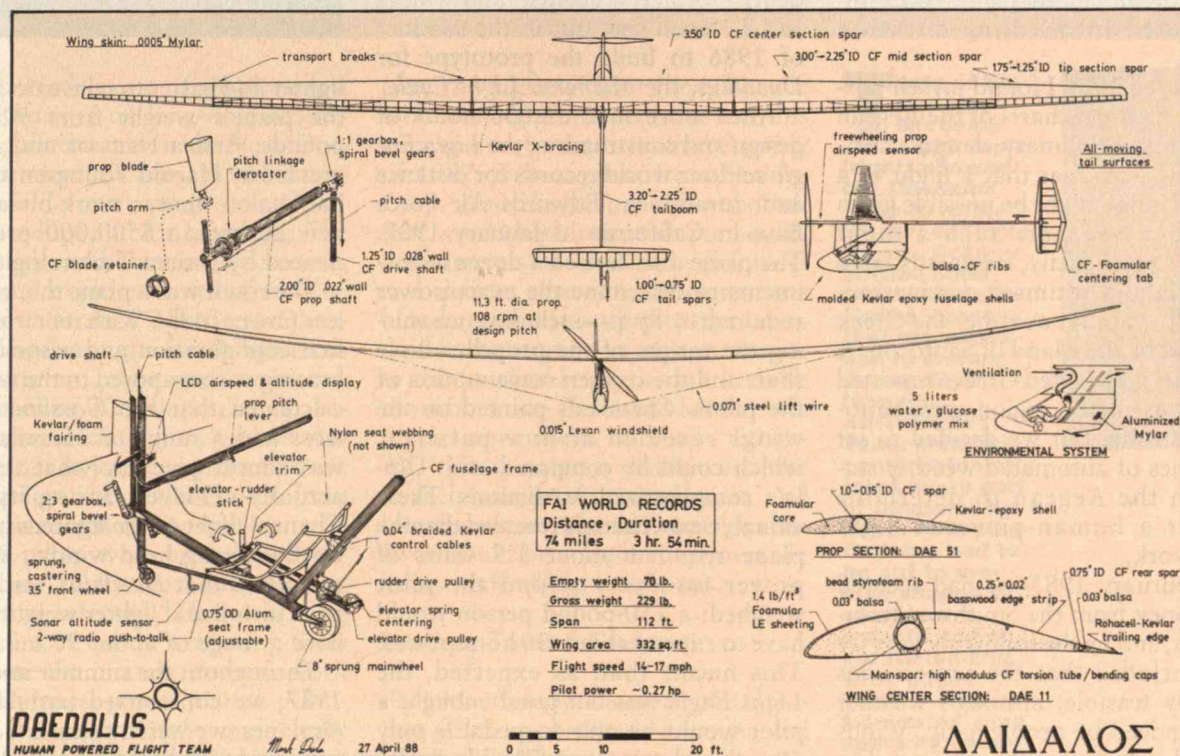
also an M.I.T. professor and director of flight operations, and I must decide if weather conditions will finally allow us to take off. From a 33-foot yacht offshore, we scan the horizon for final clues, watching each wave, flag, and—especially—two weather balloons tethered near shore.

The sea seems like glass now, but it hasn't always been calm. We have been standing by on this island for three weeks, hoping for conditions that would enable us to realize our goal. Several times the pilot has sat in the cockpit, peering into the vanishing gloom, and each time the word has come back to wait.

Human-Powered Flight Takes Off

To reach this historic moment, the *Daedalus* project has built upon many recent efforts at human-powered flight. British industrialist Henry Kremer provided the impetus to these projects in 1959, when he offered a £50,000 prize for the first plane to fly a one-mile figure-eight course. Not until 18 years later did the *Gossamer Condor*, a design breakthrough modeled on a hang glider, capture the prize. Paul MacCready's invention, three times the size of a normal hang glider yet with a similar weight, used aluminum tubes to form the wings, wires to support them, and Mylar as the skin. It also carried its tail in front, a configuration known as a canard. This type of plane, the first practical human-powered aircraft, pushed the limits of its design only two years later when a successor, *Gossamer Albatross*, captured the second Kremer Prize for flying the 22-mile English Channel.

These planes had their disadvantages: the wire bracing had high aerodynamic drag, and the tail-first design was unstable and difficult to fly, especially at higher speeds. Thus *Condor* and *Albatross*, though breakthroughs, were evolutionary dead ends. Indeed, the channel flight had required 159 of pilot Bryan Allen's estimated endurance limit of 160



The evolution of human-powered flight. **A:** *Gossamer Condor*, with its innovative, tail-first design, took the prize for completing a

one-mile figure-of-eight in 1977. **B:** The *Daedalus* team got its start with *Chrysalis*, an enormous biplane prompted by the race to fly the English

Channel, won by *Gossamer Albatross* in 1979. **C:** *Monarch*, smaller and with stored power, captured the world speed prize in 1984. Diagram:

An engineer's view of *Daedalus*, which built on previous advances. "CF" indicates carbon fiber; "ID" internal diameter.

*When the **Daedalus** project began, much of the technology required for the flight was still in the laboratory stage.*

minutes. The field of human-powered flight did not revive until Kremer offered a £20,000 speed prize four years later, motivating designers to produce smaller and more maneuverable aircraft. These efforts culminated in the flight of the M.I.T.-built *Monarch*, which completed a 1,500-meter course at an average speed of 21 miles per hour in 1984.

This generation of aircraft used new materials, including graphite-epoxy composites in the structure, specialized airfoils (the two-dimensional cross section of the wing), an electronically controlled propeller, and the lessons gained from previous flights. In the aftermath of *Monarch*'s achievement, Mark Drela and I, both veterans of that project, wondered what might happen if the new technology of the speed planes were incorporated into a long-duration aircraft.

In May of 1984 I found myself poring over nautical charts of the Aegean and doing preliminary design calculations. It was clear that a flight of a hundred miles might be possible given favorable weather. Such a flight wouldn't reach Sicily, frequently cited as *Daedalus*'s ultimate destination, but could go as far as either the Greek mainland or the island of Santorini. A colleague who visited Greece reported that winds in the region were notoriously strong, but we decided to set up a series of automated weather stations in the Aegean to determine whether a human-powered flight might work.

By February 1985 we had secured seed money from the Smithsonian Institution, and by the following year we had concluded that the project was definitely feasible, although weather would indeed be problematic. Winds were calmest during the summer, but high temperatures then would cause the pilot to overheat while pedaling. However, our data indicated that the air might be still enough during five or six spring and autumn days to attempt a flight.

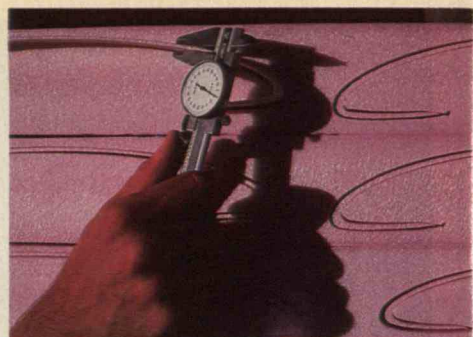
Designing the Plane

Much of the technology required for the flight was still in the laboratory stage. Drela, for example, had developed a new computerized approach to low-speed airfoil design for his doctoral thesis, but it had never been tested on an actual wing. Structural engineer Juan Cruz, who had worked at Beech Aircraft on the new all-composite business plane *Starship*, had heard about some exotic carbon fibers available only in limited quantities for satellites, but he had never seen, much less used, any.

We decided to build a prototype aircraft, a rugged workhorse that could be used for research and pilot training for the actual *Daedalus* planes to follow. Thus, an 18-member team of students, former students, and young M.I.T. faculty set out in the summer of 1986 to build the prototype for *Daedalus*, the *Michelob Light Eagle*.

After more than 15,000 hours of design and construction, the *Light Eagle* set four world records for distance and duration at Edwards Air Force Base in California in January 1987. The plane also carried a dozen experiments to determine the exact power required to fly it—including measuring the torque of the propeller drive shaft and the oxygen consumption of the pilots. Chemicals painted on the wings revealed airflow patterns, which could be compared with Drela's computerized predictions. These valuable experiments revealed that the plane required about 1.5 watts of power for every pound the pilot weighed: a 150-pound person would have to expend about .30 horsepower. This meant that, as expected, the *Light Eagle* was not good enough: a pilot would be able to pedal it only 50 miles, short of our 72-mile goal.

These lessons paved the way for designing the plane that would attempt the *Daedalus* flight. Drela refined his aerodynamic theory and modified the airfoils to correct problems near the wing tips. Cruz made the wing spars



lighter and easier to construct, cutting the plane's weight from 92 to 68 pounds. And a team of undergraduates led by Harold Youngren and Tidhar Shalom went to work building the new aircraft, a \$500,000 project financed by United Technologies.

The result was a plane that required less power to fly. With its airfoil, tail-first configuration and assortment of bracing wires exposed to the wind, we calculated that the *Gossamer Albatrios* had a range of 35 miles. That was almost precisely what the plane actually achieved during its cross-Channel flight (if the figure is adjusted for the strong head winds). We then calculated that *Daedalus*, with its refined airfoil and lighter weight, would have a range of about 90 miles.

Throughout the summer and fall of 1987, we constructed parts for two airplanes (we weren't sure if we would actually build both) that could make the historic flight. We also continued our search for the world's best human engines, a component we recognized as crucial—pilots who would be able to complete what we estimated would be a five-hour flight.



Ethan Nadel, one of the foremost U.S. authorities on long-duration exercise, collaborated with Steve Busolari to develop tests to determine how much power people could actually produce and for how long. The two also devised criteria for screening pilots, and explored ways of increasing their endurance. The Greek Olympic cycling team graciously agreed to participate in monitored workouts, and Kanellos Kanellopoulos, a 14-time national champion, enthusiastically agreed to join our project as one of five pilots eventually chosen from among hundreds of applicants.

These pilots were probably physically ready to fly the plane the day they were selected. Their training therefore focused on preparing them to operate the aircraft through work with sailplanes, power planes, a simulator, the *Light Eagle*, and finally *Daedalus* itself. In fact, the entire pilot team spent five months near Edwards Air Force Base completing this training while continuing to bicycle 500 miles a week.

Early in the project, we had thought that the pilots would be able to com-

plete the flight without food. But the more testing continued, the less this appeared to be the case. In the spring of 1987, with support from Shaklee Corp., Nadel began to develop a drink that would both replenish the liquids and deliver glucose quickly to their bloodstream. He wanted to more than double the amount of energy content in drinks already on the market. Although no one ever admired the taste of the new drink, dubbed "Ethan-All," pilots noted a distinct increase in their energy after drinking it, and blood samples showed that glucose levels could be sustained for over six hours under flight conditions.

Heading Toward Greece

Paul MacCready, designer of *Gossamer Albatross*, had earlier commented that building the plane would be easy: the logistics would be the hard part. He was right—most of my effort during the last year focused on coordinating the details of the actual flight in Greece.

More than a dozen Greek govern-

Tests of the prototype *Michelob Light Eagle* (right) allowed the *Daedalus* team to refine its aerodynamic theory. Coke bottles filled with water simulated stresses that the wings had to endure during flight (above).

ABOVE LEFT: Team members constructed almost every part of *Daedalus* by hand. Pink plastic foam had to be cut to precise shapes to provide a smooth and accurate leading wing edge. Team members fabricated wing spars by wrapping graphite fiber around aluminum mandrels, or cores.



Human-powered flight that only a year before had been a media event was becoming routine.

ment agencies and several private companies lent their support. Olympic Airways would fly the team from the United States to Greece. The Hellenic Air Force offered the use of airfields on Crete and would transport the *Daedalus* airplanes from the United States. The Hellenic Navy and Coast Guard agreed to provide ships to escort the plane during flight, act as press platforms, and stand by for emergency rescue. The Hellenic Industrial Development Bank donated funds for project operations, and the Greek National Tourist Organization provided meals and lodging.

Meanwhile, back at Edwards Air Force Base, the *Eagle* unofficially broke the cross-Channel distance record three days in a row. Human-powered flight that only a year before had been a media event was becoming routine. And the construction team in Boston completed the first *Daedalus* plane and shipped it to Edwards for testing out of the space-shuttle hangar.

After continued refinements to the plane, everything was on track for a February departure for Greece. But the Icarus side of the myth intervened. *Daedalus* was flying one of its last test flights when a gust hit it and rolled the plane to the right. As if in slow motion, the aircraft entered a phenomenon known as spiral divergence and spun gracefully to the ground. The pilot fell away as it hit and was unharmed, but the team was stunned. The crash cast doubt on the whole operation.

But instead of demoralizing participants, the crash injected new life. Team members in Boston began to analyze the accident as efforts to complete the second *Daedalus* plane, now christened *Daedalus 88*, accelerated. Computer programs unused in months were dusted off and alternatives tested long into the night. Eleven days after the crash, *Daedalus 88* departed for California and a rebuild began on *Daedalus 87*.

The new plane breezed through its tests in just four days—fortunately,

since the spring 1988 launch window in Greece was quickly closing. Experiments revealed the problems that led to the crash. To save three pounds, we had removed the aircraft's ailerons (movable controls on the wings), so the craft depended on an upward bend in the wings called dihedral for controllability during turns. But the support wire had been accidentally cut too short, so the plane had only about half the specified dihedral. The dihedral also turned out to be less effective than predicted, and rudder movement in flight was only half that achievable on the ground because the control cables stretched. Together these factors spelled an accident waiting to happen. Had the crash not occurred in California, it surely would have over the Aegean.

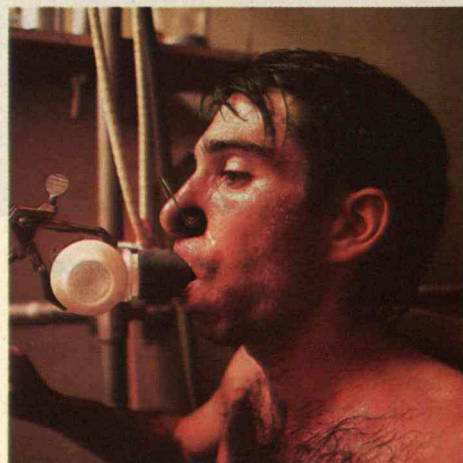
The rebuilt *Daedalus 87* made a single test flight on March 16, and the two aircraft were loaded onto a Greek military transport plane and flown to Greece for the project's final leg.

At Last, the Flight

All these details are forgotten on April 23 as the command boat, *Dulcy II*, rocks gently in the swells off Crete. A land breeze at the runway seems to be subsiding, and we are awaiting the final report from Santorini, where winds are reported between 2 and 3 meters per second (4 and 6 knots). Our absolute cutoff is 2.5 meters per second. Transmission from Santorini is difficult, with heavy static. "Jamie, please repeat your offshore wind reading three times slowly," I request. "1.4. . . 1.4. . . 1.4," comes the reply. "Now the direction." "South. . . south. . . south."

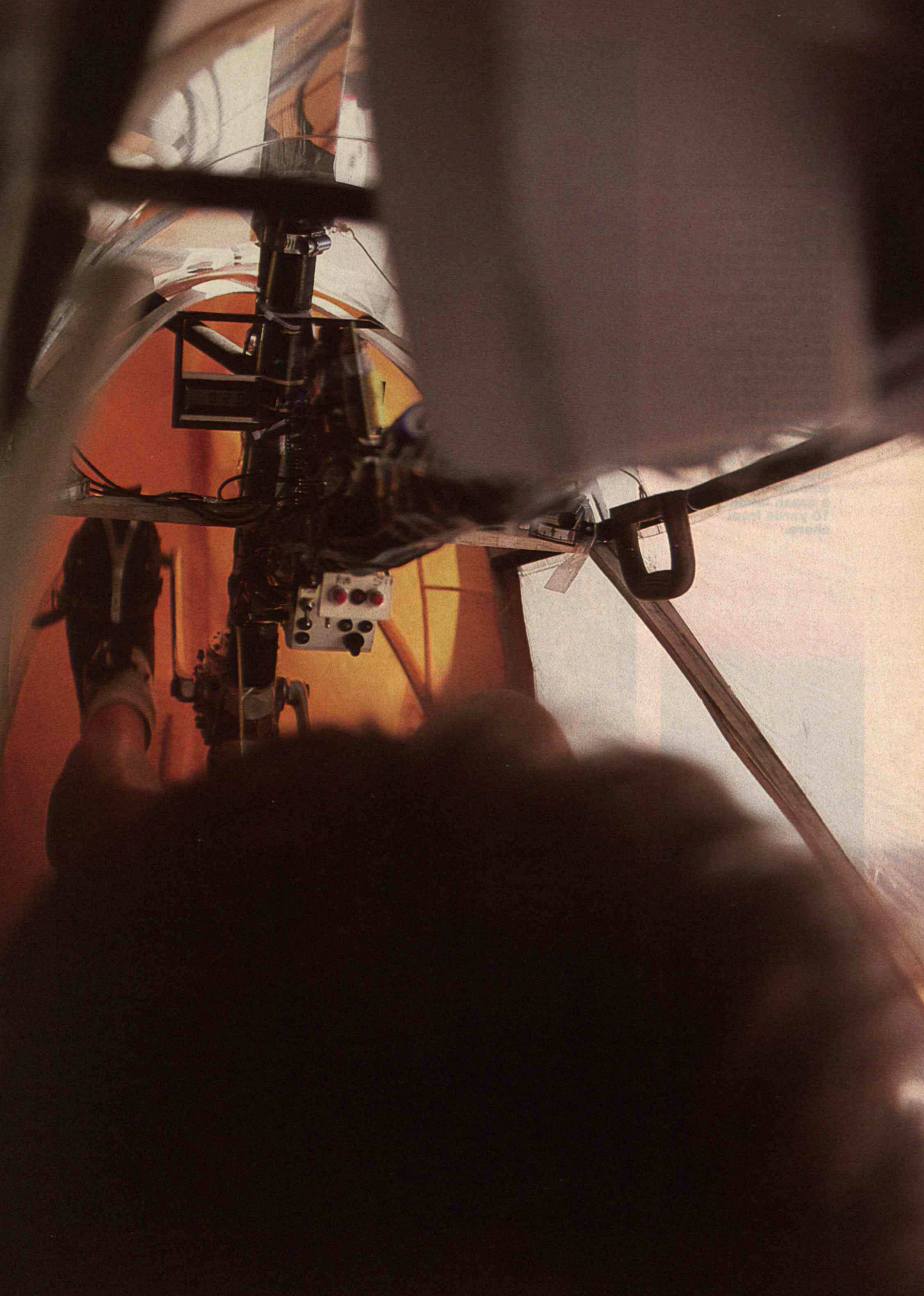
"OK," says Steve quietly. "The research part of this project is now officially over. Let's take off."

Kan has been warming up for several minutes. Since this will be an official attempt at a world record, he must lift off without any assistance except for two people steadying his wings. He adjusts the angle of the propeller blades for maximum bite and

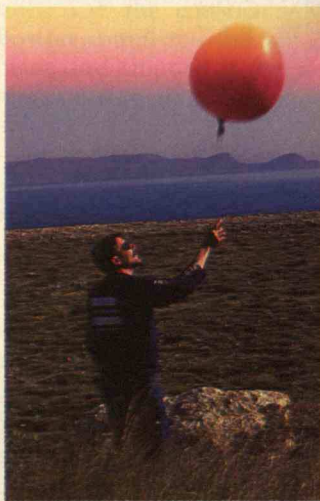


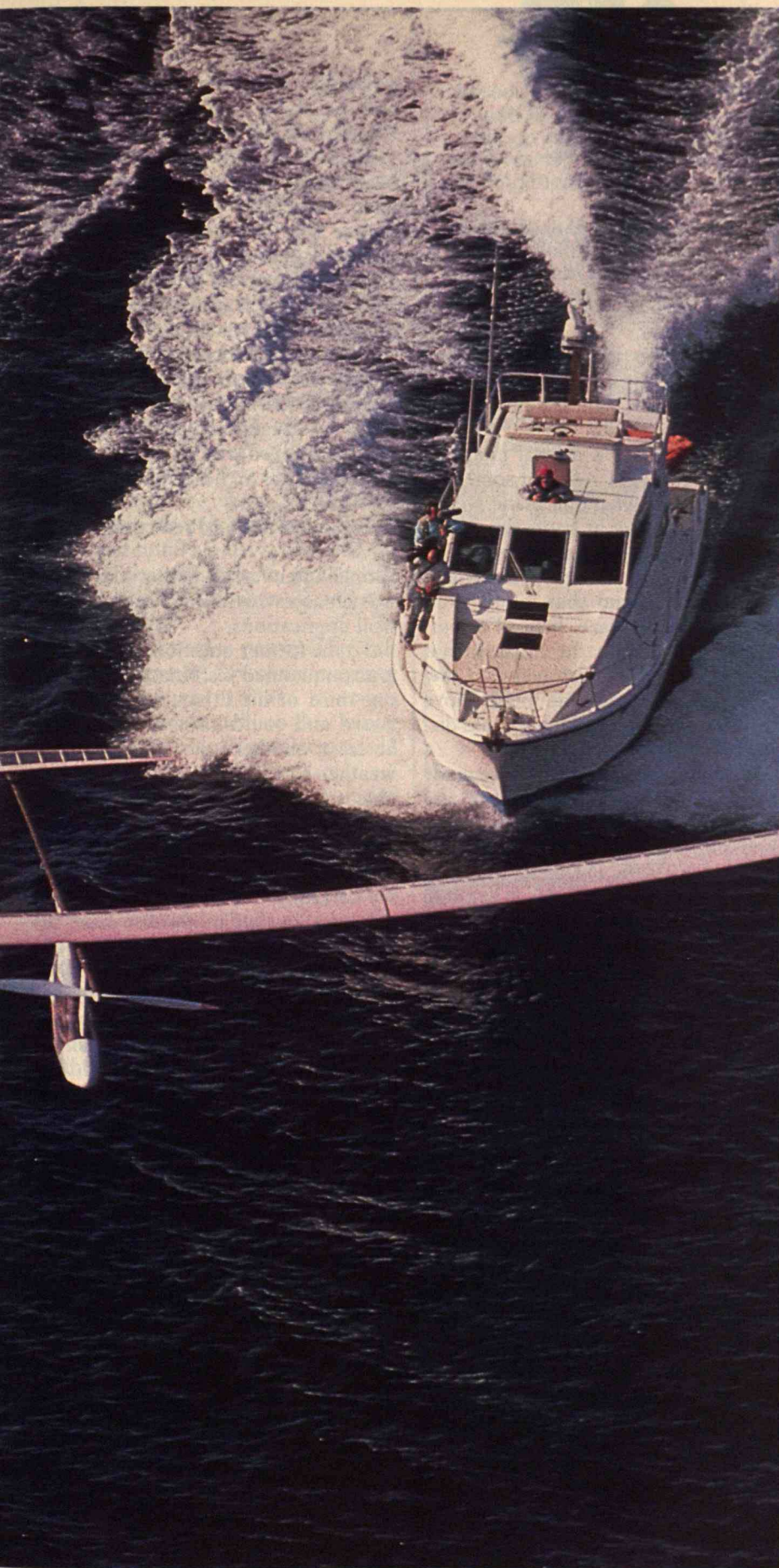
Finding the world's best human engines to power *Daedalus* proved crucial. ABOVE: The five pilots chosen from among hundreds of applicants trained up to 500 miles per week and underwent numerous tests. Exercise authority Ethan Nadel developed a special drink, dubbed "Ethan-All," to replenish liquids and nutrients during flight. RIGHT: A pilot's-eye view of the cockpit controls.





Balloons to test weather conditions proved crucial in determining when to attempt the flight. The team built a special hangar in Greece to protect *Daedalus* during the weeks of waiting. **RIGHT:** A flotilla of boats accompanies *Daedalus* as it finally makes its historic run. But high winds turn a smooth flight into a crash landing 10 yards from shore.





begins pedaling. The plane shakes and slowly begins to roll. Crew members jog alongside, then sprint, then release the plane and drop away. Inside the cockpit the rumbling of the wheel reverberates and fades to silence as the plane lifts off. Kan waves and the plane soars out over the precipice at the end of the runway. Suddenly higher than he has ever been in this plane, Kan feels no turbulence—the aircraft holds together.

At first those of us waiting offshore can see nothing. All eyes peer intently into the gloom. The first motion we see is that of the propeller, flickering at 120 revolutions per minute in the morning sun. Then a white pencil line takes form across the horizon. As the plane emerges over the cliff, a hush envelops the spectators on the sea below. Then the silence gives way to the roar of Mercury outboards as all the boats accelerate at once.

Kan has already burned off a lot of altitude and is down to 40 feet from 130. "Don't fly higher than you are willing to fall," we counseled each pilot. In fact, just two days before we had found a major crack in the tail boom in sister ship *Daedalus* 87. Any strong sideways force could have snapped off the tail and sent the plane into a spiral—safe enough from 10 or even 30 feet, but possibly fatal at higher altitudes.

Kan settles into a rhythm of 95 revolutions per minute and begins hunting for the airspeed requiring the lowest power. In the *Dulcy II*, we note the ground speed at 19 knots, meaning a healthy tail wind is at work. Team members in three inflatable Olympic boats have taken up positions nearby, the lead acting as a direction reference for the plane, the one underneath providing a height reference, and the side boat chasing any spectators who might interfere with the flight path. In an emergency the center inflatable will also try to take the plane in tow.

Twenty-six minutes into the flight we have rounded the island of Dia and are heading out to the open ocean. We



*"This is insane,"
I muse,
"but wonderful."*

expected turbulence near the island—and to take an hour to reach this point—but have experienced none. But now we encounter the first technical problem as Kan reports via radio that the altimeter—a modified ultrasonic rangefinder from a Polaroid camera—has failed. He will have to rely on reports from the boat crews.

"We've lost sight of land—another first for a human-powered aircraft!" sings Bussolari at the end of the first hour. It is eerie to scan the full horizon and see nothing, and then to look 50 feet ahead and see this huge fragile contraption moving slowly forward. "This is insane," I muse, "but wonderful." Around us cruise a small fleet of support boats, including two Coast Guard cutters, a Navy torpedo boat, three camera boats, and several well-wishers. Overhead hovers a Greek Air Force helicopter and a Cessna 150 belonging to the Heraklion Aero Club.

"Congratulations, Kan," we call. "You've just broken the straight-line record for human-powered aircraft." It must be a speed record for that distance, too—23 nautical miles in an hour and 26 minutes, an average speed of 16 knots.

The flight is now in cruise mode. Electrodes attached to Kan's chest show that his heart rate is declining slowly but steadily. His drink consumption is lagging but he complains that "my stomach is full and is sloshing around." The outside air temperature is in the low 60s, and neither overheating nor condensation is proving to be a major problem.

Bussolari is a perfect flight controller, translating frantic messages flying around him into calm, understated tones. A call from the Navy that we are 30 degrees off course turns out to be a false alarm. But another problem looms on the horizon: a large commercial container ship is aiming directly across our course. "Papa 29, Papa 29, this is command," we call, but we cannot raise the Navy boat to ask them to intervene. Even if we swerve to avoid the ship we will cross its air wake, which could rip the plane apart. Finally, we hear the Navy radioing the vessel, and it begins a tight 180-degree turn and pulls away.

At 2 hours and 48 minutes the third record of the flight falls, this one for duration. Kanellos has now flown far-

ther and longer than any human—at least in 35 centuries.

I had long had a mental image of *Daedalus* leaving Crete, but somehow I had no idea what the plane would look like arriving at Santorini. I had never let myself build up expectations that would later be crushed. What I saw was an island that loomed full grown from the haze. Instead of perceiving a speck on the horizon that expanded until it enveloped us, I saw the top of the island's mountain above the haze, and then suddenly could distinguish everything.

We always assumed that if we made it this far, the landing would take care of itself. But the team at Santorini is reporting one-foot swells with a wind of 7 knots. With *Daedalus's* ground speed of almost 18 knots, a landing in these conditions would be comparable to that of a commercial airliner in gale-force winds. A straight-in approach would risk an overshoot that would crash the plane into the trees beyond the beach. We decide to direct Kanellos east of the intended landing site, then have him turn almost 180 degrees into the wind for a final approach parallel to the shore.

Kanellos begins the left turn that will line him up with the beach. As he does so the bubble bursts before my eyes. His ground speed drops until he hovers about 10 yards off the beach, with an inflatable directly below, still giving commands. A gust seems to lift the plane. "Here comes a stall," I think.

But Kan hears a sickening crack and the controls go slack. The plane's tail twists, then the graphite in the tail boom splinters and the whole thing breaks off. At the same instant the main spar on the right side fails, and the plane begins a slow downward roll. Both wingtips come to rest on the

inflatable. The final impact is gentle and the Mylar enclosure around Kan begins to fill with water and roll over.

He pulls his feet free and dives out between the prop and a wing, ripping open the Mylar without ever being aware of its presence. His head quickly appears above the surface, holding a grin from ear to ear, and he swims into the arms of the crowd running down the beach.

Atop the command boat my first reaction is incredulity: "We flew 72 miles and fell 20 feet short?" Then I begin to laugh, applauding the exquisite choreography of whatever Greek god has orchestrated this event.

Recapitulation and Prediction

People often ask whether the flight was a success, and if it has any practical applications.

To the former question, my answer is an unqualified yes. Kanellos still had one-third of his Ethan-All "fuel" on board and could have continued for at least another two hours. If the weather had held, he may have been able to go on three or four more hours—twice as far as he actually flew. If we had followed our original plan and flown straight into the beach, we certainly would have landed on dry land, but we might also have inflicted the first serious injury in modern human-powered flight, to either the pilot or a spectator. Alfred Neubauer, a European auto racer, once observed that "the ultimate vehicle will victoriously cross the finish line and then disintegrate," meaning that it should have just enough margin to complete its task—anything extra is wasted. *Daedalus* meets that test. It was designed to fly, not to maneuver, and certainly not to land on a soft sand beach.

As for practical uses, the project may in the long term lead to new types of aircraft that could fly very high in the earth's atmosphere, or even above Mars. Such vehicles, known as "high altitude, long endurance," or HA/LE, would combine the relatively low cost and mobility of an aircraft with the staying power of a satellite. Aerodynamic conditions (known as Reynolds numbers) in these rarified environments would be more akin to those of the slow-speed, superlightweight *Dae-*

dalus than to those of conventional aircraft.

Such a platform would likely be unmanned and powered by an unconventional energy source such as the sun. Human and solar power pose similar challenges: both put a premium on efficiency because the power source is relatively fixed. Recent advances in solar cells and energy storage could combine with technology from *Daedalus* to yield a radical improvement in this type of aircraft.

Any solar-powered craft would have to fly high enough to avoid strong winds. (A wind null occurs between 55,000 and 70,000 feet.) After climbing into the upper atmosphere, these slow-flying platforms could loiter and fulfill a variety of needs, including communications, atmospheric sampling, and civilian or military reconnaissance.

The idea of a solar-powered aircraft is not new, but no government agency has been willing to make a serious long-term commitment to developing them. The Defense Department tested a small, remotely powered solar vehicle in the 1970s, and DuPont funded a manned aircraft called *Solar Challenger* in 1980, but little progress has been made since.

Projects such as *Daedalus* and *Voyager* could provide the inspiration for the next phase of research. Those efforts show that entrepreneurial aviation is still possible, and that tremendous public interest will focus on new aeronautical technology. One might, for example, stimulate innovation by organizing a trans-Atlantic race for solar-powered aircraft, say New York to Paris, or even an around-the-world flight. Perhaps humans will find that *Daedalus's* successful flight over the Aegean has tempted us to fly higher than ever before, not trying to reach the sun but drawing power from it. □

FURTHER READING

"Building the *Gossamer Albatross*," by Morton Grosser, *Technology Review*, April 1981.

"How the *Gossamer Albatross* Conquered the Channel," by Morton Grosser, *Technology Review*, May/June 1981.

"Mach .03 or Bust," by John Langford, *Technology Review*, May/June 1985.

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Management by STRESS

BY MIKE PARKER AND JANE SLAUGHTER

IF there is one factor that has erased the reluctance of U.S. management to adopt Japanese management methods, it is the Toyota-General Motors joint venture in California—New United Motors Manufacturing, Inc. (NUMMI). In just two years, the Fremont, Calif., assembly plant went from “interesting experiment” to *the* success story in U.S. automobile manufacturing. By the end of 1986 NUMMI had become both the standard and the model for the U.S. auto industry, despite vigorous denials from officials at the Big Three companies, who hated to look like Johnny-come-latelies.

In producing a Toyota Corolla and its GM version, the Chevrolet Nova, NUMMI has made U.S. managers sit up and take notice for several reasons.

□ The automaker has achieved a massive increase in labor productivity. A 1985 videotape made by GM's Technical Liaison Office for company managers claimed that NUMMI required only 14 hours of direct labor to assemble a Nova. By contrast, it had taken 22 hours to produce the J car in the same plant when GM ran it.

□ The NUMMI start-up used new equipment, new work-force methods, and new management, yet quality at the Fremont facility climbed quickly and has stayed at the top.

□ NUMMI has achieved these feats in a traditional GM assembly plant, where the technology is not particularly advanced. Furthermore, most of the workers are the same ones who had a reputation for wildcat strikes, a lack of concern for quality, and major absentee, drug, and alcohol problems while making the J car. None of these problems is evident at NUMMI.

□ Local and national union leaders are some of NUMMI's biggest boosters.

For U.S. corporations, spurred by the recession of the early 1980s, declining profit margins, and growing foreign competition, the lessons are clear-cut. You can take an ordinary factory with a unionized work-force and, by changing the management and contract, achieve productivity and quality to compete with the Japanese.

By March 1988, the team concept—as management, the popular press, and most workers call the NUMMI model—was in use or planned for at least 17 GM assembly plants,

Chrysler plants, Ford's Rouge steel operation and Romeo engine plant in Michigan, and all of the wholly or partially Japanese-owned auto plants in the United States. It is projected for GM's Saturn project, much publicized as the factory that will revolutionize U.S. auto production and enable GM to produce a small car to

*Stress
drives and
regulates the
Japanese import
known popularly
as the team
concept.*

compete with imports. And the United Auto Workers (UAW) has endorsed the team concept in national contracts with the Big Three.

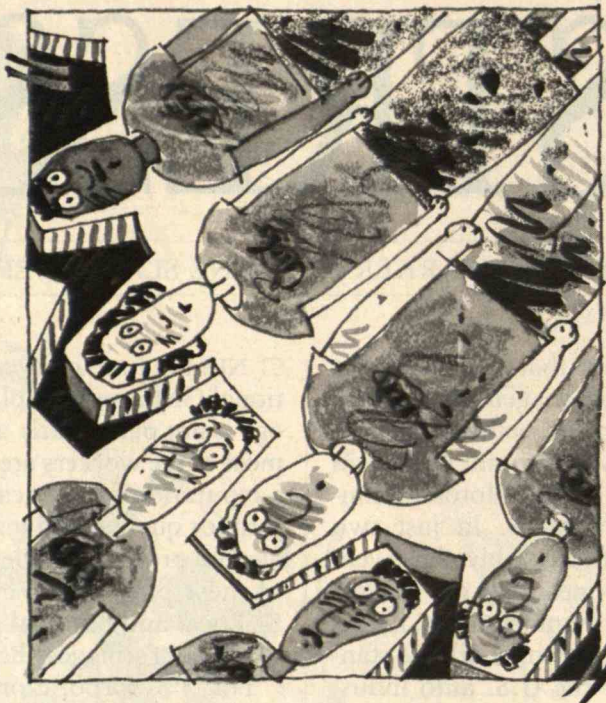
The team concept is growing in other industries as well. Makers of corn syrup and sellers of insurance have been hailed for bold innovations in labor relations through teams. Electronics, paint, chemical, oil-refining, heavy-equipment, telephone, motor, photocopying, paper, and high-tech companies have all experimented with the idea. Some of the most famous are AT&T, General Electric, Procter and Gamble, Xerox, Honeywell, and Cummins Engine. The team concept has spread into the public sector, too, with experiments in Florida, Tennessee, and Washington State public schools.

The team concept may seem to be an idea whose time has come. However, management's descriptions of what makes it work rarely mention teams—in the sense of teamwork or team meetings. In what many NUMMI managers consider the reference, *Toyota Production System: Practical Approach to Production Management*, Yasuhiro Monden does not use the term "team" at all.

In U.S. auto assembly plants, a team usually consists of four to fifteen workers plus a team leader. Above the team leader is a supervisor, called the group leader or adviser now rather than foreman, who supervises two to four teams. The team leader has no regular production job but performs an extensive list of assignments, some of which would be handled by a supervisor in a traditional plant.

MIKE PARKER and JANE SLAUGHTER are the authors of *Choosing Sides: Unions and the Team Concept* (Labor Notes, 1988). *Choosing Sides* and this article reflect their firsthand experience in auto plants—Parker at Chrysler and Ford, and Slaughter at GM and Chrysler, as well as a year of research and interviews with workers in team-concept plants. Parker is also the author of *Inside the Circle: A Union Guide to QWL* (South End Press, 1985). Slaughter is a staff writer for Labor Notes, specializing in the auto industry.

In a plant's actual operation—as opposed to the ideological hype—teams are simply the name for administrative units. For the most part, if we substituted "supervisor's sub-group" for team and "sub-group leader" for team leader, understanding would not suffer at all. There is no more teamwork, in the sense of workers helping each other, than in a traditional auto plant.



*Human beings,
not transistors, computers,
and motors, are the cogs
in the system.*

The many team-concept plants in the auto industry vary widely. Some differ from traditional set-ups mainly in that they have eliminated job classifications. At NUMMI and at other Japanese-run plants, management has implemented a total approach to manufacturing that includes a number of interdependent elements in addition to teams: "just-in-time" inventory control, technology designed to minimize indirect labor, extensive use of outside contracting, and a systematic speedup. This total production system is sometimes called "synchronous manufacturing." We have coined the alternative phrase "management by stress," however, to highlight the force that drives and regulates the system. It also describes the daily experience of those who perform the labor in such plants. In this article we concentrate on the management-by-stress version of the team concept be-

cause it has become the model toward which management is striving.

Although the most sophisticated version of management by stress originated in Japan, it is important to point out that the country of origin is not particularly relevant. We have avoided the term "Japanization" because it fogs the fact that these are *management* methods, rapidly being adopted by management everywhere. They do not require the particularities of Japanese culture to work.

Stressing the System

Management by stress goes against traditional U.S. management notions. Its operating principle is to

methodically locate and remove protections against breakdowns and glitches. To identify both weak and strong points, the system, including its human elements, operates in a state of permanent stress. The weak points break down, indicating where additional resources are needed. Just as important, points that never break down are assumed to waste resources.

The *andon* board illustrates how management by stress functions. *Andon* is a visual display of the status of each work station. At NUMMI, a board over the assembly line shows a rectangular area for each worker's station. When the worker falls behind or needs help, he or she pulls a cord and the rectangular area lights up. Thus, no light means that production is keeping up. If the light remains on for a set period (such as one minute), the line stops.

In a traditional operation, management would consider no lights to be the desired situation. Individual managers would protect that status and themselves with excess stock and excess workers.

In management by stress, however, unlit warning lights signal inefficiency. If the system is stressed—for example, by speeding up the assembly line—the lights will quickly reveal the weak points. On a few jobs, the line will stop, and management can focus on redesigning them. The ideal is for the system to run with all stations oscillating between lights on and lights off.

Stressing the system can be accomplished by increasing line speed, cutting the number of people or machines, or giving workers more tasks. Similarly, a line can be “balanced” by decreasing resources or increasing the workload at positions that always run smoothly. Once problems have been corrected, the system can be further stressed and then balanced again.

The GM videotape for managers compares a shutdown line at a traditional plant to one at NUMMI. In the former, “The plant manager, the plant superintendents, assistant superintendents, foremen, general foremen, everybody became unglued.” At NUMMI,

“It’s OK to cause a problem because that’s an opportunity for us to change something.”

There is an elegance to the idea that the system optimizes itself. After years of observing waste, many people—workers as well as management—are attracted to this vision of a rational, efficient production system. The only problem is that human beings are the

cogs in the system, not transistors, computers, and motors.

Scientific Management and Speedup

Most descriptions contrast team production, including the versions that depend most on stress, to the “scientific management” principles championed by Frederick W. Taylor at the turn of the century. *Business Week*, for example, editorializes, “Team-based systems, perfected by Japanese car makers, are alternatives to the ‘scientific management’ system, long used in Detroit, which treats employees as mere hands who must be told every move to make.”

This is part of the fantasy that is being constructed around the team concept. In fact, the tendency is in the opposite direction—to specify every move that a worker makes in much greater detail than ever before. Far from repudiating Taylorism, man-

agement by stress intensifies it.

In team-concept plants, as in traditional plants, workers have little control over basic job design. Management chooses the processes, basic production layout, and technologies to be used. While jobs are designed by “teams,” the members of those teams in the pre-production phase are engineers, supervisors, and management-selected group and team leaders. They “chart” the jobs—that is, break them down to separate acts—and then shift tasks so that the amount of work individual members have to do is more or less equal. The result is a detailed written specification of how each line worker should do each job. When GM opened its team-concept Fairfax II plant in Kansas, workers expected to have input into their job design.



Workers
*can barely keep up with the
specified job, let alone help
someone else.*

But they found that management had already selected the team leaders, who, with industrial engineers, had already laid out the jobs.

Workers do get to participate some in fine-tuning the system. It is this phase that inspires most of the rhapsodies about team concept. But once full production is reached, and the bugs revealed by management-by-stress methods are eliminated, the jobs are "standardized." Jobs are done in precisely the same way every time by every worker. The team member is told exactly how many steps to take and what the left hand should be doing while the right hand is picking up the wrench. While this may be logical from an engineering point of view, it can be hard on the workers. They are not allowed to vary their techniques to accommodate individual variations such as height or agility. They may not work faster for a short time to try to create some breathing space—the jobs are so "loaded" that this is usually not possible anyway. If they do discover a method that makes the job easier, they must share it with the supervisor, who will then take advantage of the time saved by adding another task to the job.

No matter how well workers learn their jobs, there is no such thing as establishing a comfortable pace. There is always room for *kaizen*, or continuous improvement. In his description of Toyota, Monden gives an example: management wants to reallocate jobs on a team because five workers are working every second, but the sixth—worker F—has 45 seconds of idle time. This waiting time, says Monden, should not be distributed equally among the six workers. "If it were it would be simply hidden again. . . . Instead a return to step 1 is necessary to see if there are further improvements that can be made in the line to eliminate the fractional operations left for F."

Once the line is up to speed, each worker can barely keep up with the specified job, let alone help someone else. In fact, a worker who can shave a few seconds off a task *shouldn't* help fellow workers. It is better to stand idle to reveal the existence of free time, which can then be used on a regular task.

Management by stress refines production even further by having supervisors and team leaders continually acquire workers' knowledge about the details of the production process. In this regard, management by stress does differ from Taylorism. Taylor sought to harness workers' firsthand knowledge about the production process, but he believed that such knowledge could be acquired by engineers essentially all in one gulp. Management by stress seeks to enlist workers themselves in continually "*kaizen*ing" their jobs.

At NUMMI, slow sales necessitated a cut in the line speed. Rather than allowing a more relaxed work pace,

jobs were rebalanced so that employees were still working as nearly as possible to 60 seconds out of a minute. Because management had promised that there would be no layoffs, those who became extra were assigned to observe their fellow workers and *kaizen* their jobs even further.

In addition, supervisors know the production process because they regularly work the line—which is forbidden by traditional auto contracts. The team leaders, who are union members but are often effectively incorporated into management, work all the jobs in their teams from time to time and are also expected to help "improve" those jobs. At NUMMI, some 900 workers have taken the 30-hour (unpaid) training course to qualify for a team-leader position.

Exposing Inefficiency

The remarkable record of NUMMI and management by stress results from more than a pure speedup and tighter management control. Another essential ingredient is "just-in-time" (JIT) production. Just-in-time is a "demand-pull" approach: parts are made only when the next operation needs them; no buffer stocks are kept on hand. Just-in-time saves interest costs on capital tied up in inventory and reduces the expense of warehousing. It also saves on quality control since faulty parts are detected quickly.

As with the *andon* board, management by stress uses JIT to tighten departments that never have a problem. JIT rejects the traditional "just-in-case" rationale for inventory—protecting one department from problems in another. Instead, by removing the cushions, JIT reveals inefficiencies.

However, to maintain production and protect the investment in equipment, a plant must deal quickly with any trouble that surfaces through JIT. The characteristic management-by-stress response is to let the pressure come through to production workers, team leaders, and lowest-level management, making *them* solve the problem. For example, a Mazda manual describes a situation in which a tire-assembly station builds up a large supply of tires between itself and the main line. The manual explains that this buffer is a disadvantage since it removes pressure from the tire assembler.

Keeping the system stressed means that fewer upper and middle managers are needed to monitor production. If a worker is off the job, falls behind, or does something wrong, the problem is obvious. Ideally, top management need only make a few key decisions, and the system will automatically produce a desired output to specifications as efficiently and cheaply as possible. But this can only work if the material handler, supplier department, and supplier

MIT

OCTOBER 1988



IMPROVING ON NATURE:
100 YEARS OF
MATERIALS
TECHNOLOGY

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COVER

For the Department of Materials Science and Engineering and its predecessors, it's been 100 years of improving on Nature. Take this "polar bar," for example. Henry A. Hobbs Jr., '60 (left), and Dennis W. Readey, Sc.D. '62, in the Ice Research Laboratory, are demonstrating the characteristics of a then-new ice and fiberglass "alloy," suitable for Arctic construction. It was 10 times stronger than common ice and had a tensile strength of 2,000 pounds per square inch. Photo: the M.I.T. Museum; story on page MIT 14.

Touching All the Bases

LIMITS TO FREEDOM

As the defenders of campus pornographic films point out (see "Freedom of Expression vs. Protection of Minorities, May/June, page MIT 3), there is no doubt that the Constitution insures free speech, and that right is vigorously protected by our courts. However, that right does not permeate every nook and corner of our society or every one of our institutions.

An institution has the right and the responsibility to monitor what goes on within its walls and to set the standards that it finds acceptable. Once those standards are established, change should only be undertaken with [caution] and every consideration to those whose "rights" could be affected.

The institutional right to set standards is balanced by the individual's right not to participate in that institution, but to seek an alternative that accommodates his/her beliefs and needs. When an institution accepts specious arguments concerning free speech, it is abrogating its responsibility to set its standards.

JULIAN H. CHERUBINI, '67
Dedham, Mass.

RECOLLECTIONS OF KILLIAN

I remember two things about James R. Killian, Jr.'26, whose death was reported in April (pp. MIT 8-12). He gave a speech to my class when we were freshmen in September 1954 on the economic gap between the haves and the have-nots in the world, saying that we must close the gap or there could never be lasting peace. I was impressed, and he was right: we haven't closed the gap and there is no peace. The other thing I remember is that while he was off in Washington, I was rowing in a shell with his name on it.

CARL BORCHERT, '58
Nantucket, Mass.

As an earlier graduate from M.I.T., I had known Jim Killian since a few years after his graduation. Indeed, we have been closely associated in M.I.T. affairs and in other activities for a period of almost 50 years. His death was a great loss to M.I.T., to all who care about the university, and to the nation.

ROBERT C. SPRAGUE, '23
North Adams, Mass.

The writer is honorary chairman of the Sprague Electric Co. and a life member emeritus of the M.I.T. Corporation.

NEVER GIVE UP?

The questionnaire for the new *Alumni Register* is almost embarrassing when it asks if I have achieved Nobel or Pulitzer Prizes—or perhaps even both. Little did I know, as a freshman, that such Olympian expectations would follow me from M.I.T. so far beyond graduation.

KENNETH E. SCHOMAN, JR., '67
Lexington, Mass.

INTERVIEW WAS PROPAGANDA

It was with dismay and displeasure that I read the Focus on Alumni interview with Rebecca Leaf (February/March 1988, pp. MIT 3-5). It amounted to nothing more than left wing propaganda of the worst sort. I firmly believe that *Technology Review* should not become a forum for vicious attacks on the United States.

PETER A. SCHNEIDER, '81
Harrington Park, N.J.

WE HEAR YOU

As an alumnus member of M.I.T.'s chapter of the Phi Delta Theta fraternity, I was glad to see the article on the honors that have come to the chapter of late (May/June 1988, p. MIT 6). It is a bit distressing, however, that the headline read "Frat Honors." Fraternity men regard the term "frat" as extremely pejorative, conjuring up the image of "animal houses" as presented in some movies. No M.I.T. fraternity member in my time was ever heard to use the term, and freshmen were quickly corrected if they did so through ignorance. However, don't let my letter discourage in any way the *Review's* coverage of the Greek letter societies, which enroll more than a third of our undergraduates and which engage in a variety of valuable service and competitive activities.

ROBERT M.O. SUTTON, SR., '73
Marshall, Va.

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Consensus Science: Is That All—or the Best— We Can Do?

Given how well things have gone around M.I.T. lately, it seems almost churlish to complain. The number of major contributions that this school makes regularly is embarrassingly disproportionate to its size, and the individual contributions themselves are strikingly powerful, or important, or beautiful. In my department, biology, the laboratories continue to do absolutely first-rate work, and we continue to graduate students who are in demand at every other university as faculty members or post-docs. In fact, every once in a while, the *New York Times* publishes an article saying that the Department of Biology at M.I.T. is the best in the country. On those days, everyone in the department nods his or her agreement and goes on with the work. (It's nice to be able to rely on the media to get things right occasionally.)

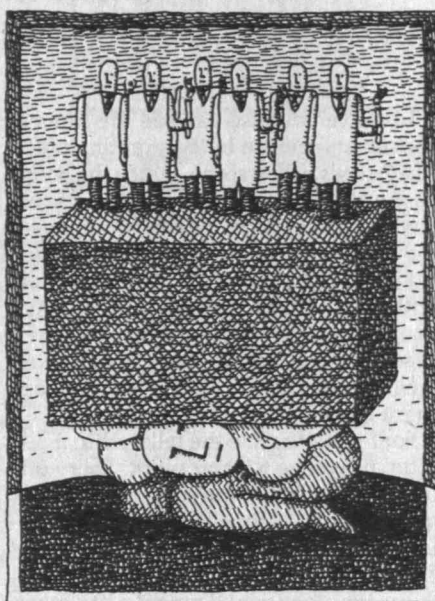
But I still think that there is something to worry about. It has to do with how things are going for our own students and faculty, as well as with the culture of science everywhere. Put briefly, we might well hope for more.

My concern was brought into focus by a recent phone call from a friend who used to be a postdoc at M.I.T. and who is now a professor at Harvard. He had just given a seminar in our department, and he was calling to tell me what a wonderful time he'd had and how lucky I was to be working in this environment. He said that every person in our department is smart, which is more than he could say for his own colleagues.

"There is only one thing wrong," he said. As he went from office to office visiting people at M.I.T., as he talked to students after his seminar and talked to professors that night at dinner, he kept encountering the same phenomenon: *everybody knows what's right*.

"Everybody at M.I.T. knows absolutely what experiments of mine have been valuable and what experiments I should drop. They know what I should do next—they are absolutely certain about that," my friend said.

"That is murder for someone like me, because I'm trying to do something new and different," he went on. "To have everybody



say [do the experiments] this way and forget about [any other] ways was very difficult." He surmised that this must be very difficult for M.I.T.'s young people—assistant professors and students. Constantly being told exactly what avenues are worth exploring must make them very narrow, he reflected. And then he said, "It must be death on creativity."

My friend's experience during one day here crystallized for me a problem that manifests itself in many ways. Put too simply, it is the growing power of consensus science and its stifling of the idiosyncratic, unorthodox—but often seminal—individual view of science.

I can see this effect very clearly when I think about the Nobel Prizes in biology. They can be divided fairly cleanly into two groups. On the one hand, many prizes have been awarded to groups who have done the experiment that the community of biologists thought was the right thing to do—the next logical step. The available technology had come together, enabling several laboratories to try to do a particular experiment, and somebody did it first. Everybody in the community acknowledged that the result was correct: you won and here is your Nobel Prize.

I'm not quarreling with such research; it has produced important results from which we all benefit. But it is really consensus science, validated by communal choice and appraisal.

On the other hand, a surprisingly large

group of winners did their work in isolation. They had great difficulty securing funding and gaining acceptance of their work. They produced heterodox results that their colleagues simply rejected out of hand; theirs were not the "right" experiments.

I could name several examples of solitary scientists. By now, one of the best known is Barbara McClintock. She worked alone studying corn plants and saw in that material phenomena that proved to be essential for the understanding of the transmission of genetic characteristics. By herself, and without community support, she produced work of fundamental importance that turns out to be widely generalizable. Yet it took 30 years and the rediscovery of those same phenomena in other systems for her work to be endorsed by her colleagues and her achievement to be publicly recognized.

It is ironic and relevant that the story of McClintock's life and the "rediscovery" of her work have become much more rapidly and widely accepted among biologists than the very discoveries that she made. The lesson of her experience is surely not lost on young investigators.

The point I want to make is that there is now a strong, clear pressure mitigating against working in McClintock's style. A new mode of operating seems to kick in when one has arrived at a certain level in science. Once-innovative scientists go on to become the heads of large research groups instead of continuing to work in a very intimate relationship with their research material.

The pressure to form large groups is difficult to resist: researchers see that the way to meet the growing competition is to make multiple and connecting contributions from a single laboratory, to be a collaborator on a large number of papers instead of the primary investigator on a few. The value, efficiency, and effectiveness of these groups is frequently debated, but quite independent of that judgment, it is clear that they emphasize group enterprise at the expense of individual effort.

The scientists at the head of large laboratories lose the opportunity afforded by that hard edge of individuality and loneliness. Worse, and more telling in the long run, the bright and vigorous young people who join these groups are discouraged from working in the style that yielded their mentors' original achievement.

FRANK SOLOMON is professor of biology. This column is based on a talk he gave to the M.I.T. Council for the Arts.

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*As he went from
office to office, he kept
finding the same phenomenon: everybody
knows what's right.*

I believe you also can see the signs of consensus science in the granting of the MacArthur Fellowships, which the *Boston Globe* calls "the genius awards." These fellowships, for which one cannot apply but rather only be discovered, were intended to support innovative people for five years with grants in the vicinity of \$300,000. I have several friends who have received MacArthurs—both biologists and non-biologists—and the difference between them is telling.

For the biologists, the fellowship made little difference to their work. Every one of them was fully funded already. But for my friend the filmmaker and my acquaintance the novelist, the MacArthur Fellowships bought time to develop their ideas. It was time they would not have had otherwise; the fellowship freed them of the need to support themselves by activities other than their art.

Why is there such a dramatic difference in the situations of these two groups of winners? It must be because the people who nominate winners in biology are recommending candidates who have already been accepted into the circle of consensus—whereas the people who are recommending candidates in other fields are saying, "Aha, that's heterodoxy. What that artist is trying to do is genuinely different, and it deserves a chance to develop." But in the sciences, that notion is not often expressed.

I said at the outset that we might well hope for more for our students and faculty. We should aspire to buck the trend toward a science dominated by group thinking. Now there are at least two ways of thinking about the way environments influence the way individuals work and grow: the fertile ground theory versus the rocky soil theory. The fertile ground theory says throw lots of seeds on the ground and do everything you can to give everybody a chance to grow. And the rocky soil theory says that true genius will survive, whether we nurture it or not; sheer survival is a test of the value of the individual—those who don't make it weren't meant to make it. The latter theory is the one I want to attack. It is a theory that treats geniuses as astonishing and powerful mutants who pop up, once a Mozart, once a Beethoven. There's no question that such genius can

overcome all obstacles, but it is extremely rare.

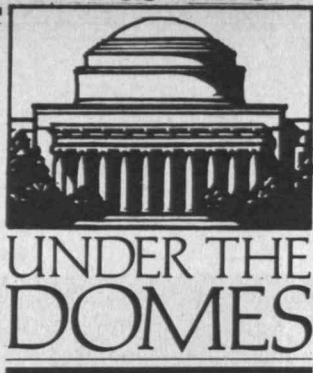
If we set up our universe with the expectation that only the Mozarts and the Beethovens will produce valuable, unique work, we lose the majority of the human potential that's out there. I think that we need to take into account the fact that individuality comes in many different guises, some of which can't grow well on rocky soil and yet are worth having. We need all sorts of people functioning as individuals and expressing themselves at the level that bespeaks their individuality—that puts their own stamp on things.

So what to do? It's not easy to think of institutional solutions to such an individual problem. I do worry about a faculty that seems to feel constrained to support itself either by attracting funding or by working in areas with the widest popular appeal. And I worry about students who seem so bent on succeeding by somebody else's set of rules that they have to follow lock-step down a path, that they are afraid to have their own ideas.

Perhaps the solution is an ancient one: we need in positions of leadership wise men and women who can look down into the community of scientists from a different perspective, who have both the power and the imagination to break the rules at the right time.

They might say, for example, "Sure, one way to get tenure is to have your name on twenty published papers in four years, to do the right experiments and win stature in your field, et cetera. . . . But another way is to do something breathtakingly lovely." They might suggest that another way to earn tenure and to succeed here at M.I.T. and elsewhere is to teach in a way that brings students to a level that they didn't even know existed before. They might encourage breaking the frame of the professor-student relationship, which here, as elsewhere, is so firmly grounded in the level of right vs. wrong, "I know/you don't know," and "you need me to get to the next step."

We have to find a way to get these kids and this faculty, who are so extremely product-oriented, off the bottom line and up into the air a little bit, so that they have a chance to breathe. □



Class of 1992: An Equation Full of Variables

The Class of 1992 made its first group appearance in a report from the Admissions Office. Mean SAT scores, ratio of men to women, apportionment of minorities, percentage of valedictorians—all fit very neatly into digits set in columns comparing them to last year's digits. Behind the numbers lie recruiting goals and hard work on the part of

both the admissions staff and the countless volunteers who interviewed candidates and read applications.

For a brief moment the results of all that effort and care are precise and quantifiable—but by the time the *Review* goes to press, the numbers will have sprung to life, filled dorm rooms with posters, jeans, and stereos, and begun to make themselves acquainted with each other and the Institute. Far less manageable in that form, but ever so much more interesting! For now, the numbers are all we have to share.

M.I.T. received 68 more applications for the Class of '92

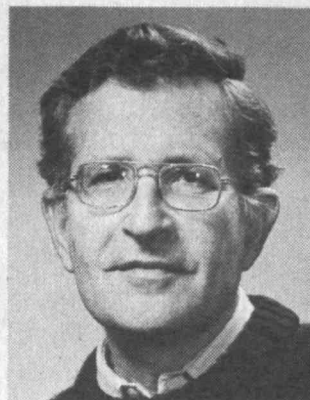
than for the Class of '91. Of the 7,436 applying, it accepted 1,831, or 24.6 percent, an increase of five students but a decrease of 4 percent from last year. Virtually the same percentage of accepted students have enrolled (55.1 percent) but the percentage of women in the class has dropped by 2.5 percent from the previous class.

The enrollment of underrepresented minorities increased by 43, making up 17 percent of the class. Native Americans, Mexican Americans, and blacks have each shown a substantial increase in numbers, while the number of Puerto Rican students has remained about the same.

The number of Asian American enrollees has declined by 26 to 178, or 17.6 percent of the class.

The mean SAT scores, both verbal and math, have declined a few points since last year—the fact that the decline reflects a national trend is cold comfort. The percentage of those students who were in the top 5 percent of their high school classes has remained stable, although 3 percent fewer of the new freshmen were valedictorians. And finally, it appears that overcrowding in the Department of Electrical Engineering and Computer Science will continue to level off—the percent of incoming freshmen indicating an intention to concentrate in EECS has declined from 23.3 percent in 1987 to 20.8 percent.

All these figures are subject to minor adjustment, as figures are wont to be, but the Class of 1992 looks strong, well-balanced, and just waiting to become three-dimensional. □



Kyoto Prize for Chomsky

Professor Noam A. Chomsky, whose theories of the nature of language have revolutionized linguistic science, won a \$350,000 Kyoto Prize in basic sciences. He is the third member of the M.I.T. faculty to receive one of the prizes.

These annual awards, which in prestige and monetary value have been likened to the Nobel Prizes, are given by the Inamori Foundation of Japan in three categories: the basic sciences, advanced technology, and the creative arts and moral sciences.

Chomsky is widely regarded as the leader of the generative school of linguistics, which views language as a particular manifestation of the human mind. The striking similarities that are encountered in the most divergent languages are the result, he maintains, of basic similarities in the intellectual makeup of humans that spring from their common genetic endowment.

His views have strongly influenced both psychology and philosophy, while his po-



TOUR DE SOL 88—M.I.T.'s solar car finished sixth out of 100 in the 250-mile race through Switzer-

land—despite two blown tires, a damaged computer, and a bumpy ride down a 40-foot embankment.

litical activities and writings have brought him to international attention independently of his work in linguistics.

Chomsky, 59, was born in Philadelphia and spent his undergraduate and graduate years at the University of Pennsylvania. Between 1951 and 1955 he was a Junior Fellow at the Harvard University Society of Fellows, where he finished his doctoral dissertation, "Transformational Analysis"; it eventually became part of *The Logical Structure of Linguistic Theory*, published in 1975.

One of the other 1988 Kyoto Prize winners, John McCarthy of Stanford University, cited for his work in artificial intelligence (AI), was a faculty member in M.I.T.'s Department of Electrical Engineering and Computer Science from 1958 to 1962. He collaborated with

Professor Marvin L. Minsky in organizing the Institute's AI project during that period and returned to M.I.T. in 1972 as a visiting professor in the Artificial Intelligence Laboratory.

Previous Kyoto prizes went in 1984 to Claude E. Shannon, Ph.D. '40, for his pioneering work in information theory, and in 1987 to Morris Cohen, '33, for his contributions to metallurgical science. □

Football: Varsity Once Again

Beginning this fall, the M.I.T. football team will compete as a member of the National Collegiate Athletic Association's Division III. Since 1978, the sport has been

played at the Institute on a club level, but as more and more of the club competitors joined the N.C.A.A., M.I.T. was faced with a scarcity of intercollegiate opponents.

In the late 1800s, M.I.T. sponsored a varsity football team; but in 1900 the student body voted 117 to 113 to abolish the sport. Over the years, however, the subject continued to resurface. A letter to *The Tech* in 1921 argued that at a school with an academic load as rigorous and ever-increasing as Technology's, adequate time for practice would be impossible. The writer did concede that "the operation of class teams, where the expense is trifling and the level of performance mediocre, is an entirely different matter. . . ."

In 1927, an unfortunately timed proposal to resurrect the football team was made the same week of a Harvard-Princeton gridiron scandal. An impassioned editorial in *Technology Review* in March of that year responded: "collegiate football in this country is no longer a game, no longer a sport, but a business—grim, high pressure, cutthroat, none too honest. The metamorphosis has been slow but relentless, until now the vast stadia of the country are little more than arenas of exhibitionism that have nothing to do with sport. Men may play the game for glory or for cash: they can no longer play it for fun."

While there are those who would say that description still holds true at some schools, time has also seen a return to a saner approach to the game at many others.

Football is now the 36th intercollegiate sport at M.I.T. to be granted full varsity status. Only Harvard University sponsors a greater number of varsity athletic teams. □



Naturalist Heads Association

The new president of the Association of Alumni and Alumnae of the Massachusetts Institute of Technology was introduced to the assembled multitude at the Technology Day luncheon, and officially took office July 1. She is Emily V. Wade, '45, former president and chairwoman of the Boston Zoological Society, and widely known for her work in conservation and animal care.

Wade has long been involved in a myriad of M.I.T. activities. She is currently midway through her second five-year term on the Corporation, and since 1985 has been chairwoman of the Corporation Joint Advisory Committee for Institute-wide Affairs. In addition to serving on several Corporation and Visiting Committees, she has been active in the development of the Alumni Association and of AMITA—the Association of M.I.T. Alumnae.

A resident of Bedford, Mass., Wade is a trustee of the Eaglebrook School, and she has been a member of the New England Deaconess Hospital corporation since 1977. For 25 years she was director of the Massachusetts Audubon Society, becoming honorary director in 1987. □



The Alumni Association paid tribute to two longtime friends by bestowing honorary membership on them. Retired manager of the DuPont Gymnasium equipment desk John H. (Murph) Murphy (left) and

Charlie-the-Tech-Tailor owner and proprietor Michael Egiros (center) were saluted at the Technology Day luncheon by departing Association President Raymond S. Stata, '57.

Past the Halfway Point and Climbing

The five-year *Campaign for the future* is only in its twelfth month since kick-off, but already it is well past the halfway mark toward its \$550 million goal.

Resource Development staff and Alumni Fund workers, as well as a handful of top volunteers, gathered on campus June 15 to celebrate the announcement by Vice-President Glenn P. Strehle, '58, that the campaign had already brought in more than \$300 million.

"The campaign," Strehle says, "has achieved remarkable success since its announcement in October 1987. We had \$210 million in gifts and pledges then; since that time we have received over \$90 million more."

Strehle attributes the success of the campaign in large part to the corps of dedicated volunteers working under the leadership of D. Reid Weedon, Jr., '41, chairman of the National Campaign Committee, and Carl M. Mueller, '41, chairman of the Corporation Campaign Committee, and to intensive efforts by M.I.T. staff.

The National Campaign Committee currently boasts a total of 175 volunteers working in 27 areas throughout the country, with chairmen and vice-chairmen in each locale.

According to Henry B. Barg, S.M.'73, director of campaign operations, whose staff concentrates on gifts in the \$50,000-\$500,000 range, "The volunteer effort has moved from a period of organization to a period of action. The volunteers are actively cultivating and soliciting potential donors. Morale is high, and everybody is feeling very positive about the campaign."

Director of Major Gifts George Ramonat, who along with Mueller is responsible for gifts over \$500,000, notes that activities in his area are being carried out largely by senior officers of the Institute, who have made approximately 110 personal visits to potential donors during the campaign's early months.

"The results have been good," Ramonat says, "and monies from alumni and friends have found their way into professorships, career development chairs, research seed funds, scholarships and fellowships. We're doing all the things that the campaign was designed to do, by building our endowment."

Joseph S. Collins, director of the Alumni Fund, reports that staff working with more than 1,200 alumni and student

volunteers have already raised \$42 million of the fund's \$100 million goal for the five-year campaign, and pledges in hand are expected to provide an additional \$10.2 million.

The Alumni Fund closed its books on June 30, reporting the second highest dollar total in fund history—\$12.4 million in gifts—from a record 28,832 alumni and alumnae. "This is a very satisfying year," according to Harris Weinstein, '56, chairman of the Fund Board, "particularly when you consider the impact that the drastic drop in equity markets, in combination with federal tax reform, had on gifts to the fund of appreciated securities in the month of December."

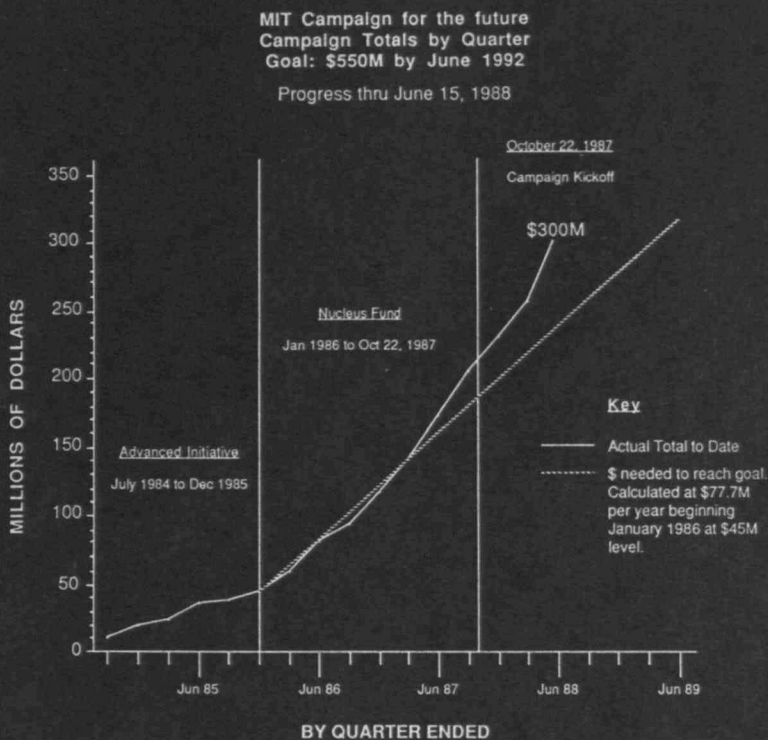
Fund organizers take great satisfaction from the increases in participation and gift upgrading, Weinstein says. This year's donor total exceeds last year's record by 1,000 donors; the last annual net increase of 1,000 donors took place five years ago. Further, the number of alumni making gifts of \$100 or more increased by 600 to a total of 11,026, a 6 percent jump. The fund is shooting for a median gift of \$100 by the close of the Cam-

paign for the future in 1992.

"Many of the volunteers," says Strehle, "have lifetime involvement in M.I.T.—first as students, then as active participants in alumni events. The campaign has given them an opportunity to think about the importance of M.I.T. to themselves and to the ideas they believe in. Thanks to their efforts, many individuals have made their largest commitments ever to M.I.T. during the past few months."

In addition, Strehle says, major contributions have been made by foundations and corporations during this period.

Among the large foundation commitments obtained recently by the Institute are a \$1 million MacArthur Foundation gift to support graduate students in the area of international security; a \$3 million Knight Foundation gift to support M.I.T.'s science journalism program; a \$1.5 million Ford Foundation gift to support programs in international security and arms control; a \$350,000 Mellon Foundation gift to support curriculum development; and a \$393,000 Getty Trust gift to support the Center for Materials Research in Archaeology and Ethnology.—Theresa Pease □







Potables, Comestibles, Memories, and Riveting Speakers

They ate Italian food in the Boathouse and Persian chicken at the Museum of Science; they sampled fabulous desserts at the Sonesta and dim sum in Chinatown. They savored a daunting array of hot hors d'oeuvres at President Gray's house and a lobster dinner at the Faculty Club. They "got down" to the music of Mick Jagger at 500 Memorial Drive and danced to the soul music of James Brown and Billy Ocean at the elegant new Charles Hotel in Harvard Square.

They got away from it all for a few hours or a few days by heading to Martha's Vineyard, the Cape, Newport, Nantucket, or the Boston Harbor Islands. They toured the M.I.T. Museum, the Computer Museum, the Ramesses exhibit at the Science Museum. They took in a Red Sox game, went roller-skating, heard lectures on topics from AIDS to what's wrong with the tenure system. And, of course, with a display of distinctive red-jackets-and-white-hair, they packed Symphony Hall for Pops and filled the Johnson Athletic Center for the Technology Day luncheon that capped several years of effort and generosity dedicated to reunion gifts.

In all, about 1300 members of 15 classes and their guests participated in Reunions '88, and the only common denominators were the assurance of being fed often and

well and the memories of shared misery and exhilaration at the 'Tute.

A Year of Work for a Three-Day Party

Members of the reunion committees, working with Alumni Association staff, had worked for at least a year (and as long as three years) to plan several days worth of menus, venues, and activities for a hundred or so people whom they had not seen in maybe 25 years and spouses they had perhaps never met. When you put it that way, it's really remarkable that everybody seemed to have such a good time.

There was a bit of what you might call graveyard humor: Edwin Hadley, '38, reporting on his class's stunning 50th reunion gift of \$7,522,000, said that M.I.T. will receive only \$4 million of that within the next few years. "For the rest of the money," he quipped, "you have to wait for the rest of us to die off."

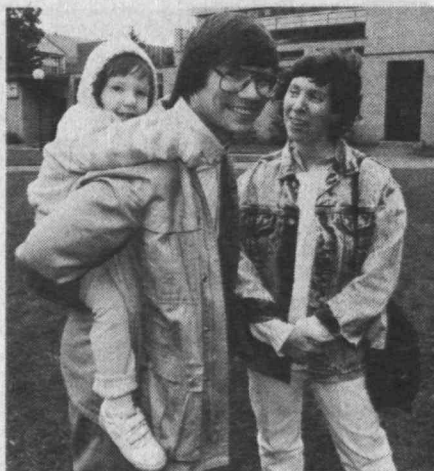
There were much more serious moments, as when the Class of '63 toured the Kennedy Library and walked through halls filled with photos of the Kennedy presidency and the assassination they all remember vividly.

Looking ahead to their 25th reunion, members of the Class of '68 paused in their dancing at the Boston Computer Museum to nominate a quarter-century gift chairman. The nominee agreed to serve on the condition that his fellow party goers give him their business cards as a pledge to

Patricia Marzilli, '63, and colleagues enjoy a classic Reunion pleasure: paging through old editions of Technique.



CLOCKWISE FROM ABOVE: *The Class of '63 "family portrait"; (top from left) Betts Weir, Hilda Bedford, Don Weir, and Norman Bedford savor mementos of the president's reception for the Class of '38; Harlan and Beatrice Paige, resplendent in the insignia of the 60-Year Class; a clearly festive couple from one of the "young classes"; the Class of '63 at the Kennedy Library; for M.I.T. Professor Alan Guth, '68, wife Susan and daughter Jenny, being joined on campus by old friends was a treat. CENTER: The boat trip to Thompson's Island was definitely a family affair.*



solicit 10 classmates each. In less than five minutes he had collected more than 25 cards. The deejay cranked up "I Heard It Through the Grapevine" and a conga line ensued, a la the California raisins.

Trends seem to be showing up in a few areas. Young classes are having more extensive reunions and making more substantial class gifts. More classes are adding variety to their plans by choosing off-campus locations from Vermont to Bermuda for at least part of their reunions. And more reunions are including intellectual content. Lectures have always been at the heart of departmental anniversaries, like this year's centennial of the Department of Materials Science and

Engineering. But the colloquia marking the 50th anniversary of Ashdown House and the Class of '63 Reunion Lectures that drew substantial numbers on a Saturday morning are a little more unusual.

With classic M.I.T. intensity, the Class of '63 became absorbed in the topics of each of its three guest speakers, barraging them with questions and only reluctantly allowing each one off the podium to make way for the next.

The peripatetic David Baltimore, '61, Nobel laureate and speaker of choice for so many M.I.T. groups, opened the series with a sobering discussion of what is now known about AIDS. Detection is now very good, Baltimore said, but treatment and

prevention have a long way to go. While AZT is effective as a drug therapy, it produces serious side effects and can be used only for short periods.

Vaccines are usually held up as the long-term hope for AIDS prevention, Baltimore said, but the situation with AIDS is much more difficult than with other viral infections. Traditional vaccines use small doses of a dead virus to trigger an immune response that protects the patient against further onslaught by the virus. But the AIDS virus works directly on the immune system, so any vaccine is going to have to be better than the virus in stimulating the immune system.

What we need, said Baltimore, is a man-



Celebrating Ashdown's 50th

Vietnamese spring rolls . . . suburban traffic congestion . . . Turkish spinach pie . . . Can engineering design be taught? . . . Meat biryani . . . Third World debt problems . . . clam chowder . . .



Professor Avery Ashdown with his constituents.

tellectual stimulation—colloquia with such luminaries as Willard Johnson (professor of political science) on financing needs of the Third World; Woodie Flowers, Ph.D.'73 (professor of mechanical

engineering) on teaching design; and Michael Meyer, Ph.D.'78 (Massachusetts Department of Public Works) on suburban traffic congestion.

Other features were less predictable—a pot-luck banquet featuring international specialties prepared by today's Ashdown residents, a concert by residents and alumni, and a dance with music from the 1940s to the 1980s.

And then there was the resurrection of the house registers—the notebooks now preserved in the M.I.T. Archives in which residents carried on dialogues with the house committees and with each other. "A quart of beer," wrote one resident in 1965, "for the guy [the house went co-ed in 1966] who 'borrowed' my pink laundry basket today, in the unlikely case of his conscience allowing him to claim the above-mentioned beer."

An anonymous question: "Graduate House coffee tastes like mud. Why?" followed by an equally anonymous response, "Because it's ground in the morning." Comments ranged from the practical—"Mankind cheers those who fix problems, not those who discover them"—to the fanciful—"I lost a copy of *Time Travel Made Simple* tomorrow in the lobby. If anyone finds it there was a reward."

After the memories, the Ashdown House reunion offered plenty of in-

ing a pad beside his bed for the inevitable ideas that occurred to him in the night.

Bose had an "advantage": he thought he didn't want to teach, but just wanted to be on the faculty in order to use the M.I.T. laboratories for acoustic research every summer. So he didn't care about tenure; he ignored the mandate to publish. And as a result, he could pour all his energy into teaching during the school year.

"Excellence in teaching is there in so many people," Bose said, "but it is dead two years after they join the faculty." The key problem in a university, he said, is that "people are rewarded not at all for teaching." As a young faculty member, he reports, he was told that publishing—even

date from the top like the Manhattan Project to design the atomic bomb. "We know the 10,000 nucleotides of the virus," he said, "and what we don't know, we know how to look for." What is needed now is funding and a sustained commitment.

A coffee break barely allowed enough time for the audience to absorb the culture shock of going from Baltimore—compact, soft-spoken, and authoritative—to Amar Bose, '51—rangy, blunt, and passionately convinced of his ideas. But the listeners clearly loved both presentations. Bose is known now as the founder of a company that makes outstanding stereo speakers. But he also has

been a faculty member in electrical engineering and computer science since taking the doctorate in 1956, and he taught many members of the Class of '63 in his first section of 6.001.

Bose wrote a doctoral thesis in statistical communication under Norbert Wiener—reluctantly, he recounts—but it turned out to be a life-altering experience. By themselves, his stories of graduate student life in the environs of a stunning intellect like Wiener were worth venturing out on a Saturday morning. But anecdotes were not Bose's primary agenda.

What he wanted to talk about was teaching. He described spending 70 hours a week preparing and teaching 6.001, keep-



CLOCKWISE FROM TOP: Michael Finson, '63, with President Paul Gray, '54; guests at the 50-Year Class reception enjoy the president's garden; Eleanor Chisholm, '49, and E. Fred Brecher, '53, enjoyed the trip to Thompson's Island despite the chill wind; Alumni Association Executive Vice President William Hecht, '61, chats with Class of '28 Reunion Chairman Abe Woolf and Ruth Woolf; the Class of '78 whooping it up at the Charles Hotel.

a manuscript he only intended to publish—would look better on his record than teaching.

To see management that gets results, Bose said, look at professional sports. "If you had tenure in professional sports," he remarked, "you wouldn't recognize the games on Saturday afternoon."

To nurture the kind of skill and dedication to teaching that he is talking about, Bose is experimenting with seniors as teaching assistants in his classes. They are carefully coached in helping students to identify the concepts that they don't understand, and the program drew so many volunteers that he had to close off the list.

The Class of '63 finished their morning with Michael Scott Morton, a faculty

member in the M.I.T. School of Management and researcher in its Management in the 1990s program. As a country that has gone from being the world's largest creditor to being the world's largest debtor in four years, Scott Morton said, the United States clearly has some problems. Management in the 1990s is looking at the impact that information technology can have on the productivity and economic strength of the nation.

Scott Morton has been involved in a study that shows zero overall improvement in American industrial productivity as a result of bringing in information technologies such as professional work stations, robotics, chips and "smart products," telecommunications,

etc. "Since we know that some firms are doing very well [after implementing new technologies]," Scott Morton said, "it is clear that some other companies are dead, but they don't know it yet."

The losers have simply laid technology on top of what they've always done, he said. The winners, on the other hand, first rethink their businesses and bring in new technologies only as appropriate. "Change the [attitudes and ways of operating of the] people first," he said, "then invest in new technology."

What Scott Morton could say for sure is that the economic environment is turbulent, the technology is constantly changing, and "business as usual won't work."—Susan Lewis □

Gifts Soar Like Daedalus: \$38 Million for M.I.T.

The traditional Technology Day luncheon was custom-designed to rekindle the pride that every alumnus and alumna must feel in alma mater. *Daedalus 87*, the backup prototype for the M.I.T.-designed plane that had been pedaled between the Greek islands of Crete and Santorini just six weeks earlier, floated above the 1,500 assembled graduates and their guests, its gossamer wings stretching over much of the length of the Johnson Athletic Center.

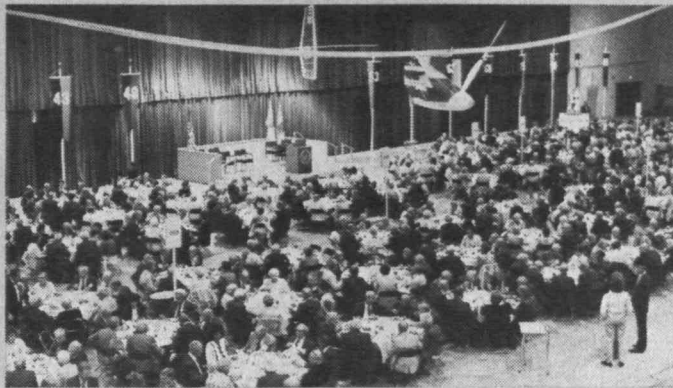
The luncheon got underway when Associate Dean of Engineering Jack Kerrebrock introduced a dozen members of the *Daedalus* team, several of whom traveled to Cambridge for the occasion. (Pilot Kanellos Kanellopoulos was preparing for the Olympics by bicycle racing in Europe.) And 13 M.I.T. quinquennial reunion classes, back to celebrate their achievements and share their memories, learned that the eight gift-raising classes had given a record-breaking \$38 million to M.I.T. The gifts from the major reunion classes (25th, 40th, and 50th) included contributions from the past five years and pledges for the next five years.)

Of the alumni gifts, President Paul E. Gray, '54, said that they were for him "an overwhelming and tremendously heartening experience. M.I.T. is truly blessed by its alumni," said Gray.

M.I.T.'s newest alumni/ae had announced on Commencement Day a senior gift of more than \$6,900 to establish a Class of 1988 scholarship—a program subsequently enriched by a challenge fund from the Class of 1938. In addition, said the graduating seniors, they have pledged at least \$17,800 to the Alumni Fund during the next four years.

From the Class of 1983 came a reunion gift of over \$23,000, said Raymond S. Stata, '57, president of the Alumni Association; in all, 68 percent of the class have made gifts to M.I.T. since graduating. The Class of 1978 presented a reunion gift of more than \$50,000 and added close to \$24,000 to its student aid fund, which now exceeds \$113,000 and funds four scholarships. A total of \$58,000 was reported by Stata from the Class of 1973, with \$21,000 of that designated for its student aid fund.

Then Stata called on Class of '63 reu-



With the ultra-light Daedalus 87 overhead, some 1,000 alumni, alumnae, and guests enjoyed the traditional Technology Day luncheon.

ion gift chairman L. Robert Johnson to report that his classmates had broken not one but two M.I.T. 25th-reunion records—the largest total gift, \$3,220,390, and the largest participation, 72 percent of the class. Raising money may be hard, said Johnson, but it's different when the object is "an institution to which we all share commitment." And many of his classmates told him, reported Johnson, "that records are made to be broken."

Next came Class of '48 reunion gift chairman Denman K. McNear, who recalled his class's 40th reunion challenge—a gift of $2\pi + \Delta$. While some had feared that delta would have a negative sign, not so, said McNear: the total topped \$6.6 million, a "sensational response" that made the committee's task "a grand, exhilarating experience."

In the 50th reunion class report, reunion gift chairman G. Edwin Hadley, '38, and major gifts chairman Norman B. Leventhal, '38, said they had their own "Massachusetts miracle" to present—a fund of \$4.1 million for M.I.T. from 75 percent of the class. In addition, they said, members had made plans for giving close to \$3.4 million more, in the form of bequests.

From the Class of 1928, led first by the late James Donovan and later by Walter C. Smith as reunion gift chairmen, came a total of \$1.269 million. And then another record: \$23.7 million, including two large bequests, from the 65th reunion class of 1923.

Furthermore, the Alumni Fund will close its 1988 year, announced Stata, with total gifts of at least \$12 million from a record 28,000 donors.

In responding to the gifts, Gray added

a second challenge to that of continued support of M.I.T. for all the Institute's alumni and alumnae. Tackle a major national problem—scientific illiteracy—urged Gray.

The problem is easy to identify, said Gray—the result of an "educational system that continues to produce students who are unfamiliar with science and more or less incompetent in mathematics." But it is not so easy to solve, he said, because it happens in 30,000 school districts throughout the country. "You live there," Gray told the graduates, and he challenged

his audience to make their influence felt locally to raise the quality of science and mathematics teaching.

"We tolerate scientific illiteracy at our national peril," said Gray.

The occasion also saw two long-time members of the M.I.T. community "who have gone the extra mile in behalf of M.I.T. students and alumni over the years" surprised with honorary membership in the Alumni Association:

■ Michael Egrious, owner and proprietor of Charlie-the-Tech-Tailor, whom Stata described as "an integral part of the M.I.T. community for 60 years, and his father for decades before him."

■ John H. (Murph) Murphy, retired manager of the equipment desk in DuPont Gymnasium, saluted by the Alumni Association on behalf of "all the athletes and hackers who were the recipients of Murph's sage advice and genuine humanity and went forth to make one more try." (In 1987, the Classes of '62 and '57 pooled resources to have the equipment room named for "Murph.")

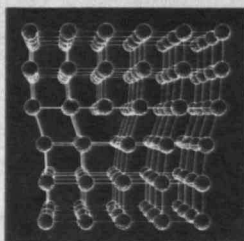
Others cited by toastmaster Stata:

■ Claude H. Lupis, Sc.D.'65, of Sydney, Australia, the reunion participant who traveled farthest. In all, said Stata, alumni representing 64 classes and 13 countries were present.

■ Walter P. Muther, '13, representing the oldest class (the 75-year class) present.

■ Emily V. Wade, '45, whom Stata introduced as incoming president of the Alumni Association; Wade officially took office as of July 1, 1988.

■ Edmund M. Dunn, '73, for his service as chairman of the Technology Day Committee planning the events of June 2 and 3.—John Mattill □



M.I.T. Celebrates 100 Years of Living in the Material World

BY STEVE NADIS

The century of existence of this department has encompassed the whole of the Industrial Revolution and the emergence of the modern, technologically based society," said Professor Merton Flemings,'51, chairman of M.I.T.'s Department of Materials Science and Engineering (MSE). "Our graduates have been major contributors to these changes, and we intend that they make similar technological and societal contributions over the next century." Flemings spoke last June on the occasion of the department's centennial celebration. (See also the article on page MIT 49.)

The department, originally called Mining Engineering and Metallurgy, has had half a dozen different names since its founding in 1888. The current designation was adopted in 1975 to reflect the department's broadening focus. In addition to metals, the department's research areas now include semiconductors, superconductors, ceramics, polymers, and composites.

Professor Emeritus Cyril Smith,'26, has witnessed two thirds of the

STEVE NADIS is a frequent contributor to Technology Review.

department's history firsthand. "When I studied metallurgy back in 1924, the things we learned were things somebody would have known in the early 18th century. We learned how to treat ores, how to design and operate furnaces, and all about smelting processes. Although there had

*The discovery
of useful materials
has been inspired by the
search for beauty, fueled
by aesthetic
curiosity.*

been enormous increases in the scale of operations, we did almost nothing on properties of metals." In fact, Smith added, few alloys were in use at the time that were not known 2,000 years before.

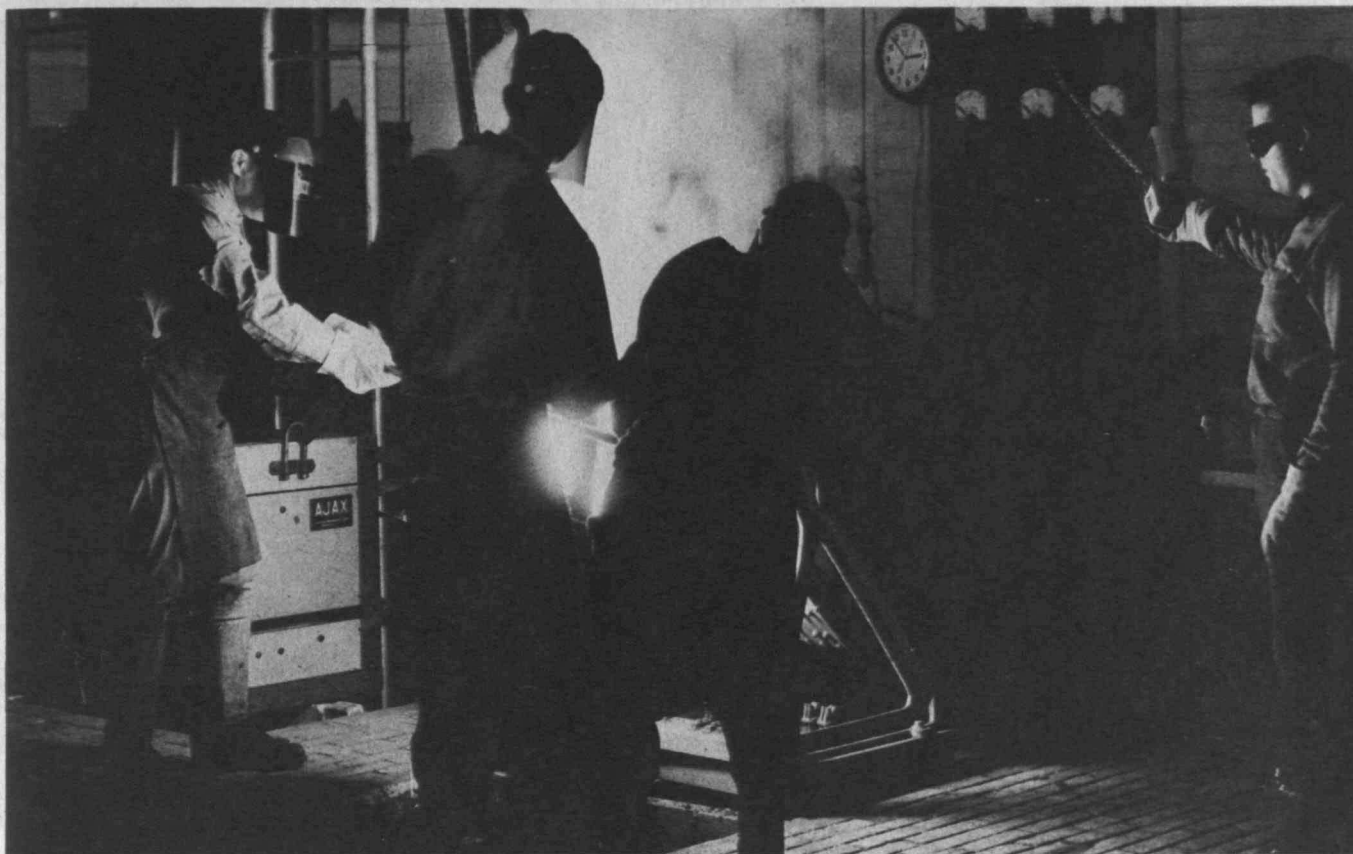
Giving another historical perspective, Robert Cahn of Cambridge University, a lecturer at the anniversary celebration, described how materials science has evolved over the centuries from what had begun as "an

alchemy of cooking, of adding small impurities for different experimental purposes."

Techniques introduced early in this century—X-ray diffraction and metallography—opened up the field to real change. X-ray diffraction revealed the atomic structure of crystalline substances. Metallography obtained information about a material's structure by examining light reflected off the surfaces. More detailed understanding of internal structure also came with the introduction of the transmission electron microscope around the 1950s and the scanning tunneling microscope, which was developed just three years ago.

Knowledge of structure and how to control it is now the foundation of modern materials science, because scientists realize that the properties of all materials depend on the manner in which atoms arrange themselves into crystalline arrays or disordered "amorphous" states.

Understanding how things are put together on an atomic and molecular level, Smith said, will ultimately provide the basis for an intellectual approach to the physical structures of the universe—biological, geological, and astronomical.



"It is an exciting time for those of us in the field of materials," Flemings agreed. "It is a time when most developed countries recognize materials as one of the three key technologies of the future, the other two being information and biotechnology."

Materials processing, Flemings said, is a key to productivity and international competitiveness. "It's processing that enables us to put 2 million circuit elements on a single silicon chip, where 25 years ago we could put just one."

Electronic materials such as silicon are today assuming enormous economic importance, but as Flemings noted, the steel industry remains vitally important to the industrialized economies. And the manufacturing of steel is an industry on which expertise nurtured at M.I.T. has had tremendous impact.

Work on the thermodynamics of steel-making done by the late John Chipman, for example, during his more than 35 years on the M.I.T. faculty, laid the basis for modern developments in steel manufacturing, Flemings said. And the AOD process (argon oxygen decarburization)—one of the main modern steel-making processes—was developed by William

Krivsky, '51, while he was working at Union Carbide in the 1960s.

M.I.T. graduates are heading up major overseas steel companies, Flemings said. Here at home, the heads of Allegheny Ludlum, Chaparral Steel Co., and Lukens Steel Company, all major American manufacturers, are M.I.T. alums.

Entrepreneurial graduates have also started and run dozens of other companies in the materials field, their products ranging from electronic devices and superconducting materials to cast and fabricated sculpture.

Research by M.I.T. faculty and students has led directly to new industries. An example is Rheocasting, developed by Flemings' own research group and now an important commercial process for forming metals in the United States and the basis of a new enterprise sponsored by MITI in Japan.

As part of Technology Day, materials science research demonstrations showcased cutting-edge technology. Exhibits included the new high-temperature superconductors, which have the potential to transform the industrial world in the same way that the invention of transistors did in 1948, and thin-film superconductors,

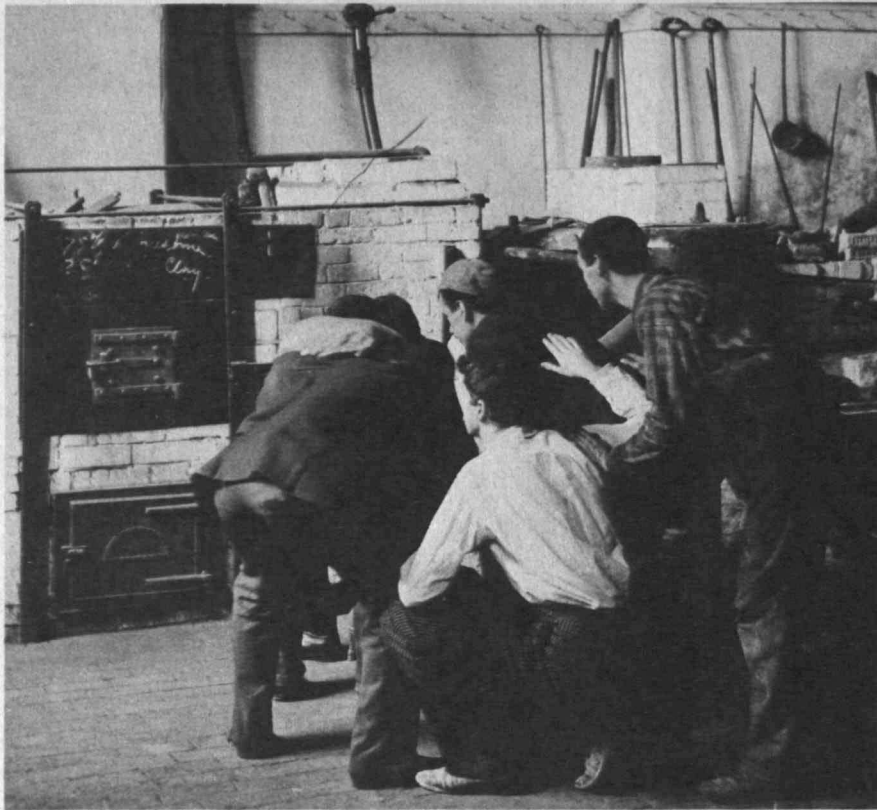
which may have widespread applications in computers. Research continues on semiconductors, the foundation of today's solid-state electronics industry. Advances in fiber-optic materials are fueling developments in high-speed communications and computation.

Also on display were high-temperature ceramic materials, which could become important engine components, and lightweight, super-strong composite materials such as those that made possible the *Daedalus* human-powered flight. "The aircraft was made almost entirely of materials which did not exist until a few years ago," President Paul E. Gray, '54, noted in his Technology Day remarks.

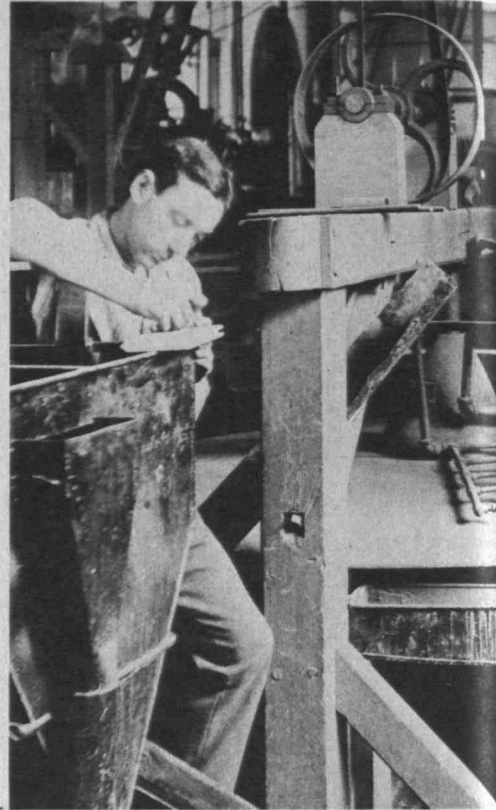
A Familiar Tune

Despite the current excitement in the field of materials science and M.I.T.'s leading role in that area, the U.S. industrial base is in serious trouble. Productivity in the United States is growing at only 0.8 percent per year, as compared to 3.2 percent in the rest of the industrial world.

To illustrate the problem, M.I.T. School of Management Dean Lester Thurow, a Technology Day speaker,



1.



2.

posed the following question: "Suppose I asked you to write down any civilian product you'd have to buy here [in America], because that product wasn't built anywhere else in the world. In 1957, the list would have gone on for hundreds of items. Today, there is just one thing you can only buy in the U.S.—player organs. If you want to buy a player piano, there is a Korean-made version, but player organs are only made in the U.S. The problem is, of course, that we won't have a very high standard of living exporting player organs."

What happened, Thurow explained, is that "the American economy died and was replaced by a world economy." The United States went from a position of economic superiority to merely being one of many competitive countries. One reason that U.S. companies are at a competitive disadvantage, Thurow said, is that "we get ourselves tied up in knots suing each other. CBS Records was suing Sony. That's why Sony bought CBS Records; it was cheaper than paying the lawyers."

Furthermore, Thurow added, the American work force is not competitive with that of Japan or Germany. Thirteen percent of the adult work

force in the U.S. is functionally illiterate, as compared to only .5 percent in Japan. Only 72 percent of Americans graduate from high school, while about 92 percent graduate in Germany. As a result, companies like IBM "have to teach Algebra I and Algebra

*I think
necessity is
the mother of
improvement, not
invention.*

II." And while 70 percent of the chief executive officers in European and Japanese companies have technical expertise, only 30 percent of their American counterparts do.

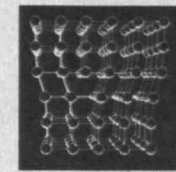
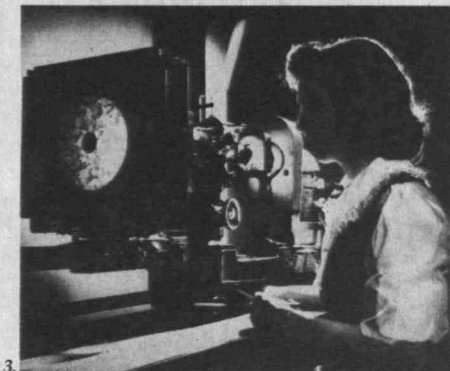
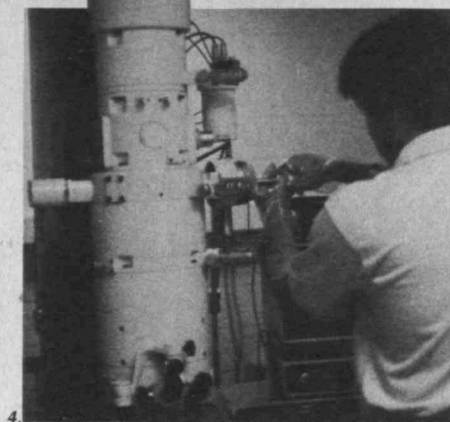
Thurow managed to inject a thought that was at once humorous and sobering: "Suppose everyone had to take the synonym section of the SAT exam," he said. "For the word 'leader,' perhaps 85 percent of Americans would choose Rambo. I'll remind you of two facts about Rambo: he was illiterate, and he couldn't get along

with any other human being."

American industry needs a new breed of technologically literate leaders. A new M.I.T. program called "Leaders for Manufacturing" is designed to produce graduates who—by virtue of rigorous training in both business and technology—will be in a position to help revitalize manufacturing industries.

M.I.T. has assembled a commission—including both Thurow and Flemings—to study the decline of productivity in the United States. The commission will make recommendations for the nation as a whole, and will also suggest what the Institute should do with regard to its education and research efforts in the area of manufacturing and materials processing. (Results of the study are expected this fall.)

M.I.T.'s Materials Processing Center (MPC) was formed in 1980 to link M.I.T. researchers with government and industry. Sixty-eight companies are members of a "collegium," which provides them with access to research findings at the center. Another 50 companies send staff to M.I.T. as visiting scientists. "They are really partners, not just patrons or observers," explained Professor Ronald Latani-



The changing focus of Materials Science.
1: Watching for the blink, the bright flash of light at the end of

the silver refining process, 1901.
2: Slime tables used to clean and concentrate lead and copper ores, 1901.
3: Photographing crystal structures with a metallograph, signalling the focus on atomic and molecular structures of materials, 1950s. 4: JEOL 200cx transmission electron microscope, 1983. 5: Prof. August Witt's semiconductor crystal growth lab and growth furnace control area is the most sophisticated in the U.S.

sion, the MPC director.

Beyond M.I.T., Latanision has worked for the creation of a state-wide research center—the Massachusetts Advanced Materials Research and Development Corp.—which will link the top materials scientists in the state with various industries in an effort to translate basic research into commercial products.

Where Does Discovery Come From?

Even with a concerted effort in applied research, Cyril Smith suspects that many important discoveries will come the old-fashioned way. "We often hear that necessity is the mother of invention," Smith said. "I think necessity is the mother of improvement, not invention." Throughout history, "the discovery of useful materials has been inspired by the search for beauty, fueled by aesthetic curiosity. . . . Perceived necessity will encourage development, but it discourages discovery; new things are by their very nature misfits."

The development of most new technologies, according to Smith, follows a common path: "First, the discovery of some pleasant effect for individual enjoyment; second, improvement by

craftspersons who have learned how to work with diverse materials; third, the development of a technology to replicate what society seems to want. . . .

"Virtually every material and method of treating it known to the 19th-century engineer originated as decorative art," Smith said. For example, rotary motion was used for drilling and shaping beads long before the invention of the axle and wheel. It took 300 years before a lathe developed in 1600 for working with ornamental ivory was used for "serious manufacturing."

"Today important discoveries of materials are likely to be made by people who are called scientists," Smith said. "Yet most scientists will admit that their search is in large measure driven by aesthetic excitement."

From Sculpture to Auto Parts

A prime example of technology growing out of art occurred at M.I.T. some 25 years ago, when an artist working in the Materials Science Department developed a new foundry process—styrofoam vaporization. The technique offered a much more efficient way of making cast sculpture. "Today

that same process is widely used in industry for making automotive parts and other components used throughout the world," Flemings noted.

Richard Polich, S.M.'65, another T-Day speaker, founded Tallix Industries in 1970 to make the new foundry process available to sculptors. Helen Frankenthaler, Roy Lichtenstein, and Frank Stella are among the artists who have had pieces cast at Tallix.

"Most of us [in the materials field] work on problems that are stated and can be solved within the existing body of scientific knowledge," Polich said. "In a sense, we know what we are looking for. But the artist works in a space where intuition and imagination are as important as method."

Smith believes, similarly, that true understanding of the nature of materials won't come until thinking and feeling, science and art, are more widely integrated. "Things you can calculate are marvelous, yet you must always remember that you can only calculate within a boundary." Metallurgy is, in essence, simply a matter of "shaping" things. Indeed, he added, "from 1988 B.C. to 1988 A.D., most of the marvelous properties of materials were discovered by human beings using their fingers." □

Space University Achieves Lift-Off

BY STEVE NADIS

During an April 1987 conference at M.I.T., plans were drafted for a new type of learning institution. The International Space University would be a training center for the world's space leaders of the future. The ultimate goal was for an orbital campus offering students the ideal vantage point from which to study space.

To the uninitiated, the idea may have had the ring of science fiction. (Revered sci-fi author Arthur C. Clarke did, in fact, deliver the symposium's keynote address.) Yet 14 months later, on June 20, 1988, the ISU became a reality, opening its doors at M.I.T. to 105 students from 20 countries.

"There was a great deal of enthusiasm at the founding conference, along with disbelief that it could really materialize," noted conference chairman Peter Diamandis, '83. "People said, 'This is a great idea, we'd love to see it happen, but there's no way it can be done in a year.'"

At first, the conference was simply going to explore the *possibility* of a space university. However, as interest in the concept grew, Diamandis and his partner, Todd Hawley, decided to push for the establishment of ISU. Hawley moved from Washington to Boston to work full-time toward that goal. In the midst of that all-out campaign, he continued his graduate studies in space policy at George Washington University. Hawley is now ISU's administrator.

Diamandis has juggled a similarly

STEVE NADIS is a frequent contributor to Technology Review.

A team of visionaries with an average age under 26 founded a new institution, raised \$1.3 million, and recruited 105 students from 20 countries.

impossible work load. In addition to being deputy administrator of ISU and director of the 1988 program, he is also a Ph.D. candidate in aerospace engineering at M.I.T. and an M.D. student at the Harvard Medical School. The schedule doesn't allow for much free time, or sleep, he admits.

"Todd and I decided that unless we could pull this off within a year, we'd lose all the momentum built up at the conference," Diamandis said. "So we went for it."

How did two 26-year-old graduate students launch a one-of-a-kind advanced study program in little more than a year? Clues may be gleaned from a poster, called "Peter's Laws," found on Diamandis's ISU office wall. Rule Number 1: "If anything can go wrong, fix it! (to hell with Murphy!)" 2. "When given a choice—take both!" 3. "Multiple projects lead to multiple success." ... 7. "If you can't beat them, join them, then beat them." 8. If it's worth doing, it's got to be done right now." ... And, finally, Rule 17: "Patience is a virtue, but persistence to the point of success is a blessing."

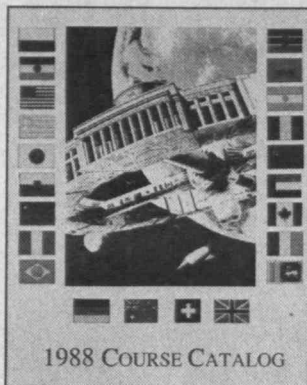
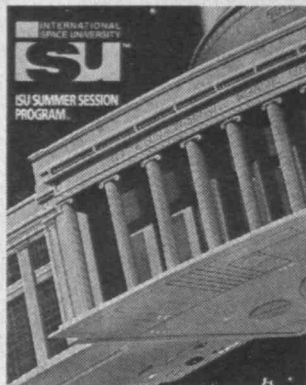
Diamandis has been an unrelenting "space fanatic" ever since attending a

planetarium show in the fifth grade. "Something clicked," he said. "I knew that space was going to be the focus of my life." He built his first robot later that year. Next he built rockets and electronic launch systems. Finally, in the eighth grade, he won a rocket launch contest.

Hawley, on the other hand, didn't become a convert until the advanced age of 20. His moment of realization occurred while reading *The High Frontier*, a book by Princeton physicist Gerard O'Neill that explored the possibilities of large-scale colonization and industrialization of space. "I became mesmerized by it," Hawley said. "It seemed like the direction for humanity to go. I had grown up in Spain—a country which, in the late 1400s, decided to make the New World its cause. Space is the New World for me." He and Diamandis met as undergraduates through SEDS, Students for the Exploration and Development of Space, a group that Diamandis founded in 1980. In 1985, Diamandis, Hawley, and Bob Richards—who founded the Canadian branch of SEDS and later helped gain Canadian support for ISU—joined forces to form the Space Generation Foundation. "The idea

Peter Diamandis, '83, (standing) the director for the first academic "term" of the International Space University, is no paper-pushing administrator. While pursuing a Ph.D. and M.D., he's also developing an artificial gravity sleeper to help astronauts avoid physical damage from extended periods of weightlessness. (See page MIT 22.)





was that everyone born since the launching of *Sputnik* in 1957 is part of the space generation," explained Diamandis, one of the group's directors. "The foundation was a way to channel our energy and keep working together," he said, and it pushed a number of projects, ISU being the most prominent.

"We didn't originate the idea of an international space university," Diamandis said. "But we are the instigators."

Bringing the project to fruition required a heroic effort on the part of Diamandis, Hawley, and Chris Mau, who became ISU's associate administrator in January 1987. Mau was recruited from a Cambridge venture-capital firm to raise money for ISU. "He's a young go-getter," Diamandis said. "That's one thing we have— young blood throughout." Both Mau and Jennifer Glass, ISU's director of communications, are 25, making for an average staff age of 25½.

Getting Off the Ground

Among their first orders of business was finding a home for ISU. According to the plan, the university will remain a summer program for the first five years, each session hosted by a different country and university. In 1992, ISU will switch to a full-year format based at a permanent site or sites. Eventually, they envision a campus that includes a space-based facility for research in a "microgravity" environment.

With the support of President Paul E. Gray, '54, and Associate Dean of Engineering Jack Kerrebrock, Diamandis was able to secure M.I.T. as host of ISU's first summer session. Next year, the university probably will be based

in Europe, perhaps France.

The board of directors was formed within a week of the 1987 conference and included a number of the event's participants. For example, Diamandis said, Andrew Stofan, head of NASA's Space Station program, "came as a speaker and left as a board member." Other members include: Mark K. Miller, president of Boeing; John F. Yardley, president of McDonnell Douglas; Robert Anderson, chairman of Rockwell International; Lew Allen, Director of Jet Propulsion Laboratory; M.I.T.'s Kerrebrock; former Secretary of the Air Force, John McLucas; and Ian Pryke, head of the European Space Agency's Washington office. These "heavyweights" in the space community were all contacts from Diamandis's and Hawley's previous space activities.

Aided by such endorsements, Mau and the rest of the ISU staff prepared to launch a major fundraising offensive. The budget for the entire summer program totaled \$1.3 million. The largest single item was \$1 million to cover tuition, housing, and meals for 100 students.

"Once the students arrived, they didn't pay a penny," Diamandis said. The remaining \$300,000 covered faculty salaries, transportation costs, and housing, plus a small overhead for ISU.

Financial support came from NASA, the European Space Agency, governments, corporations, foundations, and individuals. The USSR Ministry of Higher Education, for example, pledged \$100,000 toward the support of the 12 Soviet students who attended ISU.

Diamandis spent four months searching for the best faculty candidates from all over the world. One

novel twist was that Diamandis and Hawley both hired a few of their former teachers from M.I.T. and George Washington University to serve among this year's 30-member ISU faculty.

With the help of the new faculty, a curriculum was designed. Unlike traditional aerospace programs, which often have a narrow, technical focus, courses at ISU were offered in eight general areas: space science, architecture, business and management, policy and law, satellite applications, resources and manufacturing, life science, and engineering. To ensure a "broad education," every student took the same courses, regardless of his or her individual speciality.

"Space is an interdisciplinary field, and ISU is designed to reflect that," Diamandis said.

One of the subjects, "Space Life Science," has been a longstanding interest of his. "Two years ago, I tried to get a subject like that taught at M.I.T. or Harvard Medical School. I was told there was no funding, no textbook, and little interest. That was one of my motivations for starting ISU. Now we have a subject in space medicine, and soon we will be producing a text."

The other major component of ISU's 1988 academic program was the International Lunar Initiative. Students worked in teams to study the feasibility of setting up a base on the moon. The project involved architecture, engineering, life sciences, and economics. "NASA is interested in our report," said Hawley, whose master's degree thesis was on a related topic. "We'll also give a copy to the Soviets."

Part of the ISU experience is "structured learning." But an equally impor-

(Facing page) Todd Hawley, the administrator of the International Space University. (Right) Bernard Burke, '50, M.I.T.'s Burden Professor of Astrophysics, gave ISU students an overview of space science.



tant part, according to Diamandis, is interaction between students and faculty members from different cultures. To facilitate communication, every student admitted to the program must be fluent in English and one other language. "Students learn about their differences and similarities and, we hope, form longstanding friendships," Diamandis said. "One scenario I look forward to is that someday a U.S. engineer working on the lunar base will run into an official from another country, an old buddy from ISU. Suddenly, all the barriers break down..."

ISU received more than 350 applicants from 41 countries. To get so many different countries involved, Hawley approached various foreign embassies and consulates and even traveled to Moscow to meet with Soviet officials. Diamandis, Hawley, and Richards also did some "networking" at the International Aeronautics Federation Conference held in Brighton, England, in October 1987.

Their efforts paid off, as the caliber of student applicants was rated "exceptional" by Susanne Churchill, a member of the admissions committee. Churchill is on the faculty of the Harvard Medical School and director of the life sciences program at ISU. One hundred and five of the top candidates—from countries including Brazil, Canada, China, Germany, Great Britain, Italy, Japan, Kenya, the Soviet Union, Sri Lanka, the United Arab Emirates, and the United States—were selected in the spring.

Students will receive neither grades nor formal credit. "These students are phenomenally motivated," Diamandis said. "They'll have the opportunity to meet, work with, and learn from

the best people in the field—benefits that go far beyond grades and accreditation."

There has never been an international university for space studies, nor are there clear precedents in other fields. Since it is, in essence, an open-

ended experiment, Diamandis wanted to be careful not to inhibit creativity. "Our goal was to bring together the top students and top faculty from around the world," he said. "We did that. Then we stepped back and watched the magic happen." □

The Class of '88

The International Space University (ISU) held its first academic "year" from June 20 to August 20 on the M.I.T. campus; 105 students from 20 countries attended.

"Our students and faculty, taken together, represent current and future leaders in space fields," said Peter Diamandis, director of ISU '88. Here is a look at some of the members of the class of '88:

■ Chris Sallaberger, from Toronto, Canada: Sallaberger just received an undergraduate engineering degree from the University of Waterloo in Ontario. He was employed before and after graduation by SPAR Aerospace in Canada, where he worked on "Canadarm," the "arm" on the American space shuttle.

"It's a long day [here at ISU]," Sallaberger said. "Hour for hour it's about the same as a master's degree program, all packed into one summer." Sallaberger is planning to do graduate work at Berkeley in space robotics and then "apply to the Canadian Astronaut Corps to man the space station."

■ Jane Deakin, a spacecraft systems engineer at British Aerospace in London: Deakin has conducted "concept studies" on *HOTOL*, the British Space Shuttle, and *Columbus*, a proposed space station.

"The students here are really motivated. There are 105 people who are all

confident, who all want to speak. The debates go on and on. The atmosphere is electric..."

■ Maria Antonietta Perino, a nuclear engineer from Turin, Italy: Perino has worked for the Aeritalia Aerospace Company for the last two years. She has proposed research on a new type of material—thin-film amorphous silicon for solar cells. "My idea is to use these cells in space. The great advantage is that you can roll the solar cell in a sheet and deposit it in any shape." She's also working on a new type of gyroscope that uses superconducting material.

■ Alexander Halimon, a university student from Moscow: "Our visit here is one of the results of the summit. Gorbachev and Reagan didn't talk about us specifically, but about the exchange of students between the two countries. That's a good idea."

■ Christine Connor, of Andover, Mass.: Connor majored in science, technology, and international policy at Georgetown University.

"Here you eat, drink, and breathe space. [Besides the academics], it's a really unique cultural experience. Not just the socializing, but also working together professionally. A Chinese man in my [lunar design] group wants to come up with a 'product'—meaning an important document that people will want to read."—Steve Nadis □

Robocot

Peter Diamandis, '83, believes our future lies in space, and he's not going to let a little thing like gravity—or the lack thereof—spoil his vision. "Living on a planet simply because it has gravity is going to become primitive," he says.

However, as a medical student at Harvard and a lifelong space aficionado, Diamandis is well aware that prolonged bouts of weightlessness can have deleterious effects on the human body: bones and muscles atrophy and the cardiovascular system weakens. To prevent such adverse effects, Diamandis invented the "artificial gravity sleeper" (AGS), a spinning platform that produces a force on the body comparable to the force one experiences while standing upright on earth.

Diamandis hit upon the idea in 1983 during his first year in medical school. He had been writing a science fiction story about a space colony whose inhabitants slept in a rotating section of the colony. "After thinking about it, I decided that it wasn't such a bad idea," he says. So he sketched out a design for a rotating unit small enough to be practical on a spacecraft.

No one to whom Diamandis mentioned his idea thought it would work, however, until he talked to Larry Young, director of M.I.T.'s Man-Vehicle Laboratory, two years later. "Let's investigate it," said Young. "You never know." A little encouragement goes a long way with Diamandis: he took a break from medical school and entered the Ph.D. program in the Department of Aeronautics and Astronautics.

He spent his first year in the program taking subjects in space engineering. Then—after obtaining grants from the National Institutes of Health, the American Heart Association, and the Space Foundation—he spent the next six months building an experimental AGS, following the basic design conceived in 1983.

The centrifuge, which is roughly the size of a narrow bed, has its axis of rotation centered at the subject's head. This provides maximal acceleration at the feet and none at the head. At a rate of 24 revolutions per minute, a person on the AGS experiences acceleration of one gravity (one g) at the level of his or her feet.

The device can be used both for sleeping or for exercise. In the sleep mode, a person lies on an air or water mattress, wearing a blindfold to prevent disorientation. In the exercise mode, the subject lies

*An idea
that originated in
science fiction may have
space and medical
applications.*

down and pedals a bicycle "ergometer," performs leg compressions similar to climbing stairs, or does the equivalent of deep knee bends.

The first question was, is it possible to sleep on this thing? People were very dubious, Diamandis says. "They said it would be like sleeping standing up."

Diamandis, however, is not one to be deterred by a little skepticism—or a lot of skepticism. As the first "human guinea pig," he spent a number of nights sleeping in the unit. Then for his master's thesis, he and a co-researcher watched a paid subject sleep on the device for nine consecutive nights in the summer of 1987. During the latter sessions, the subject, Todd Hawley (now Diamandis' partner in the International Space University) was hooked up to devices that monitored his heart rate, brain function, and other physical indicators.

So far, more than two dozen subjects or "gyronauts"—ranging in age from early teens to late 60s—have spun in the centrifuge. "No one has gotten motion sickness or other problems," Diamandis says.

Now Diamandis faces a tougher challenge—demonstrating that time in the AGS actually yields physiological benefits.

You are not aware of it, but in a one-g field, your body is constantly being stressed," Diamandis explains. Fluids are pulled towards your feet, so the cardiovascular system has to fight gravity to move blood around. Bones are compressed by the weight of the body. Muscles work to hold the body upright, thereby exercising the heart and producing electrical impulses that stimulate bone growth. In a weightless environment, all those systems can slack off.

In a widely cited 1967 study, subjects were confined to bed for periods of weeks or months to induce effects similar to those

encountered in space. Fluids gravitated towards their heads; heart and other muscles weakened measurably. But experiments showed that the simple act of standing for three hours per day could prevent a test subject's bones from decalcifying, for example.

Other experiments have suggested that the immune system is also dependent on gravity for normal functioning. Under conditions of weightlessness, T cells—the bodyguards of the immune system—were shown to have only 3 percent of their usual activity. However, when these same cells were spun in a centrifuge, their activity returned to normal. "What does this mean?" Diamandis asks. "People aren't getting sick in space; they appear to be healthy. But it raises a red flag—something to look into."

In an effort to minimize the physical drain from weightlessness and confinement in a small space, American and Soviet astronauts typically devote two to four hours per day to conditioning. "But if [it's possible to accomplish] some conditioning during sleep, they may have to spend less time on exercise bikes, leaving more time for science experiments," Diamandis suggests. His next step is a series of tests to determine whether spinning enhances the value of exercise inside the centrifuge.

Detailed planning is needed before the AGS can be converted from a laboratory model to a working unit. A practical configuration has yet to be drawn up. For example, Diamandis asks, do we stack the centrifuges on top of each other to conserve space, or do we spin several astronauts on the same large disk, with their heads positioned near the center? And if there is a benefit, how many nights per week or hours per day would suffice to provide the desired salutary effects?

The young space researcher conceded that the way to go may ultimately prove to be large rotating spacecrafts that provide their own artificial gravity. "But the engineering for that is much more complicated," he says.

Meanwhile, the idea has gathered considerable interest. NASA would like to test Diamandis's system at their Ames and Johnson research facilities. And the Texas Medical Center in Houston hopes to use his space centrifuge for cardiovascular conditioning of spinal cord injury patients confined to beds.—Steve Nadis □



CLASS NOTES

17

The purpose of this column is twofold. First, we want to hear from you and about you. As Van Bush, '16, wrote in his essay, "The Builders," 45 years ago, there are those whose vigorous building is done, and they sit in the shade and encourage the young men. What, then, are your reactions to the news in *Technology Review*? Your encouragement to today's M.I.T. graduates? Do send your news and thoughts back to me to be shared with your classmates.

The second purpose of this message is as always the painful one. We have word of the passing of two classmates. **Samuel H. Creighton's** widow, Doris, informs us that Sam passed away in August 1987. Sam, a mechanical engineering graduate, had spent his professional career with DeLaval Separator Co., retiring in 1970 to Clearwater, Fla.

Robert Gannett, also a mechanical engineering graduate, passed away last November, leaving two sons and their families. Following duty as a navy ensign in World War II, his career included positions with Eclipse Machinery Co., Norm-Hoffman Bearing Corp., Oiljak Manufacturing Co., and Curtiss Wright, from which he retired in 1960.—**Don Severance**, Acting Secretary, 39 Hampshire Rd., Wellesley, MA 02181

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As indicated in an earlier issue, I had ambitious plans to make our 70th reunion last June a notable event. Despite my plea for your participation, the handicaps of age, decreased members, and distance from M.I.T. resulted in my being the sole representative at the annual Technology Day activities. It was nevertheless a happy event and an opportunity to renew friendships with many M.I.T. graduates.

Two days later the spring meeting of the Cardinal and Gray Society took place at Endicott House in Dedham. This group of M.I.T. graduates, out over 50 years, is an outgrowth of our 1918 reunions. It was a most happy occasion. Over 75 alumni and spouses attended. The day was delightful, and Endicott House and grounds were spectacularly beautiful. The speaker, Philip Khoury, associate dean of M.I.T.'s School of Humanities and Social Science, held the audience in his hand with his talk on the Middle East.

A cordial note from Dorothy Gore notes the death of her husband, **Edward Gore** on March 10, 1987. We recall the pleasure of being with the two of them at class reunions. . . . We also note the passing of Mrs. Harry Camp, widow of **Harry Camp**, who died in 1983.

It is with great sorrow that I record the passing of Rhoda Tavener, wife of **Charlie Tavener**. Charlie and she had planned to come to our 70th reunion in early June. They had their airplane tickets and hotel reservations in Cambridge. Two mornings before their scheduled flight Rhoda suffered a fatal heart attack. Both Rhoda and Charlie have been the most devoted of our class-

mates. Our deep sympathy goes to Charlie.—**Max Seltzer**, Secretary, 865 Central Ave., Needham, MA 02192; **Leonard I. Levine**, Assistant Secretary, 519 Washington St., Apt. 15, Brookline, MA 02146

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You may recall that members of the class of 1919 attending the 65th reunion voted favorably for a class reunion in 1989. We aim to do just that, if we can. We have **George Michelson** to thank for attending a 1918 class meeting when a similar matter was discussed. Many items must be considered by our reunion committee before we write to each of you to find out if you would be able to attend a reunion in 1989.

We regret to have to inform you of the deaths of some members of our class. **Royden L. Burbank**, our class agent, died April 9, 1988. During his life, he was active for the benefit of M.I.T. His health had been poor, and he had to cancel his attendance at our last reunion. We shall miss him.

George R. Bond, Jr., died April 8, 1988, due to a series of strokes. His daughter, Phyllis B. Duncan, notified the M.I.T. Alumni Association, and we are grateful for this advice. Readers, please take note that our other classmate with the same name is living in New Jersey.

We learned of the death of **Pierre Blouke** on December 17, 1987, from a prior inquiry as to whether he could attend a joint class reunion sponsored by class of 1918. He was a longtime resident in Beaverton, Ore., and had been a successful architect in the Chicago area. We recall his attendance at one of our recent reunions.—**W. O. Langille**, Secretary, P.O. Box 144, Gladstone, NJ 07934, (201) 234-0690

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Attendance at Technology Day included **Frank Maconi** and **Buzz Burroughs**. Sorry I was unable to be there.

William C. Forbes died on February 14. He lived at 42 Maple St., New Bedford, Mass. A graduate of Dartmouth College, he received his bachelor's and master's degrees in Course X at M.I.T., earning his doctorate at Lehigh. He was associated with Amoskeag Manufacturing Co. and then as chief chemist at New Bedford Rayon Co. His widow, Glenna, survives him. . . . **Gene Sloan** of Salt Lake City died in February.

Welcome word comes from **Sam Schenberg**, who retired to Miami Beach, Fla., 5600 Collins Ave. Sam reports that he is in good health, well looked after by his wife of 68 years. "Always proud to be an M.I.T. graduate," says Sam. . . . **Harold Bibber** of 2587 Berwyn Rd., Columbus, Ohio, writes that he survived a broken hip and is now repaired and in good health.—**Harold Bugbee**, Secretary, Apt. 702, 313 Country Club Heights, 3 Rehabilitation Way, Woburn, MA 01801

21

My only class news this month was a fine letter from class president **Cac Clarke** reporting on events connected with Technology Day in early June. As planned, Cac and Maxine flew to Boston. **Helen St. Laurent**, who had not planned to go, was offered a ride, and consequently was amongst those present on Technology Day. Others at the luncheon were **Frank Wiselan** and his daughter and **Don Morse**.

The Clarkes attended Pops with their daughter, Sallie, who just graduated from a course in photography at the New England School of Photography in Boston. "An excellent program with John Williams conducting," says Cac. On Technology Day, the Clarkes attended the memorial service in the chapel. Thirteen members of our class were listed as having died in the past year. The morning symposium in Kresge was also attended followed by the sherry party put on by the *Review*. The Clarkes attended the luncheon, the social hour in McCormick, and ended the day with a delightful dinner with Anne and John Mattill, editor-in-chief of the *Review* at the Hyatt Regency. Sounds like a grand day.

No obits this month. I am grateful.—**Sumner Hayward**, Secretary, Wellspring House E64, Washington Ave. Ext., Albany, NY 12203; **Samuel E. Lunden**, Assistant Secretary, 6205 Via Colinita, Rancho Palos Verdes, CA 90274

22

We apologize for the misspelling in the July notes of **Crawford Greenewalt's** name and for the incorrect name of **John Goodnow's** company, which should have been stated as Hardware Products Co.

John M. Deutch, '61, provost, has advised the class that Professor Arthur P. Mattuck, head of the Department of Mathematics, has been reappointed Class of 1922 Professor for an additional three-year term; and that associate professor of brain and cognitive science, **Jeremy M. Wolfe**, summa cum laude graduate of Princeton, has been appointed to a two-year term as the next holder of the Class of 1922 Career Development Professorship. Professor Deutch, in a letter to class president **Parke Appel**, says, "We at the Institute are once again in your debt for the gifts that endowed the Class of 1922 Professorships."

William B. Elmer has received another honor. The board of directors of the Optical Society of America on April 29, 1988, elected Bill as a fellow of the society in recognition of his distinguished service in the advancement of optics, particularly for his significant contributions to the optical design of reflectors for illumination purposes. As previously noted, Bill is also a fellow in both the Institute of Electrical and Electronics Engineers and the Illuminating Engineering Society.

Your secretary attended Technology Day activities last June 2-3. The only other classmate on hand was **Marjorie Pierce**. From the figures available for older classes, it appears that the 65th re-

union is a cutoff point for substantial interest by older alumni in alumni affairs.

An April 17, 1988, clipping from the *Daily Hampshire Gazette* of Northampton, Mass., tells us that **George T. Boli's** widow, Maude Morton Boli, who died in Florida last summer, willed over \$50,000 to Smith Academy, a public school in Hatfield, Mass., that she had attended prior to going to Smith College. The Hatfield School Committee intends to establish a trust fund to provide continuing income for school use. The Smith College records show that the Bolis had no children.

Robert W. LeMare, retired president and owner of LeMare International, Inc., of New York died January 13, 1988, at his home in Charleston, S.C. He attended M.I.T. for one year, then transferred to University of California from which he graduated. He is survived by his wife, Elizabeth Pancoast LeMare, two daughters, and two grandchildren.

Word has just been received of the death of **Robert P. Ramsey**, on July 19, 1982. A note from Patricia A. Beckman of Defiance, Ohio, to the Alumni Association says, "Mr. Ramsey was proud of his association with M.I.T. His papers and history of contributions in the diesel engine and gas turbine fields are in the archives of the Ohio Historical Society." Ramsey had been president of R.P. Ramsey & Co. of Mt. Vernon, Ohio.

Harold O. Berry, died April 16, 1988, in a nursing home in Wakefield, Mass. He had a long career in the manufacture of kitchen stoves and ranges. He was vice-president of Florence Stove Co. in Gardner, Mass., until the late 1940s when the company was sold. Then he became plant manager of Glenwood Range Co. in Taunton. This plant was eventually shut down because of labor problems but, after sale to Caloric and then to Raytheon, manufacturing continued in Ohio. Berry continued on as chief engineer. He retired in 1987 from Glenwood after 65 continuous years in the industry. Berry, a widower for 20 years, is survived by two sons, Warren O., '49, and David, their wives, six grandchildren, and nine great-grandchildren.

On a personal note, I had the pleasure of working closely with Berry in connection with a number of patent matters for the Florence Stove Co. prior to the war.

Louis H. Hobbs, died May 26, 1988, in Newport, R.I., at age 94. The 1961 *Alumni Register* lists him as a materials engineer with the U.S. Navy. Beyond that, I have no information as to his subsequent career or as to any survivors. From the 1922 *Technique*, I find that he entered M.I.T. as a junior in the class of 1921 after graduating from Dartmouth with an A.B. degree. However, he got his degree from M.I.T. with our class.

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The 65th reunion was celebrated in grand style at the luxurious Royal Sonesta Hotel in Cambridge. Those attending were Winnie and **Fred Almquist**, **Phyllis Davenport**, **Bernard Flynn**, Elizabeth and **Dick Frazier**, Lee and **Harry Kalker**, Marian and **Bill LaLonde**, Betty and **Howard Lockhart**, **Conchita Pearson**, **Albert Pyle**, Mary and **George Rowen**, **Isabelle Skinner**, **Roscoe Smith**, Mary and **Royal Sterling**, Kay and **Julius Stratton**, Florence and **Walter Webster**. Miriam and **David Joy** had reservations and plane tickets but were unable to attend because Miriam broke her right knee cap in a fall.

Wednesday night we had dinner in a private dining room with President Paul Gray, '54, and his wife Priscilla as our guests. Thursday noon we were bused to South Boston to the World Trade Center, where we enjoyed a smoked chicken luncheon and a view of Boston Harbor. That evening we enjoyed a pre-Pops dinner of Boston schrod. Friday everyone attended the Technology Day luncheon which, by the way, was far superi-

or to previous luncheons. At this time, the class gift to the Institute was announced, in excess of \$23 million.

The banquet on Friday night was held at the M.I.T. Museum where again we viewed the class movies. It is always fun to see ourselves as we were. Before departing, we all raised our glasses and toasted the 70th reunion. We are now accepting applications for chairman of the 70th.

Prior to the business meeting held on Friday, June 3, resignations were received from **Tom Rounds**, first vice-president; **Dick Frazier**, secretary-treasurer; and **George Rowan**, class agent. At the business meeting, the following slate of officers were elected: **Royal Sterling** as president, **David Joy** as first vice-president, **Roscoe Smith** as second vice-president, **Harry Kalker** as third vice-president, and **Fred Almquist** as secretary-treasurer. Since there were no takers for the duties of class agent, it was decided to eliminate this position. Sterling stated he would handle any duties of this office as they occurred.

By vote of the officers, we elected four honorary members: **Phyllis Davenport**, **Conchita Pearson**, **Isabelle Skinner**, and **Mary Sterling**. All were present at the meeting.

Of the original class of approximately 850, 230 are still living. In the past five years we have lost 109 classmates. Those of you who are living, please write to me and tell me what you and yours are up to.—**Fred Almquist**, Secretary, 63 Wells Farm Dr., Wethersfield, CT 06109

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Technology Day is the day when the M.I.T. president tells what he hopes his bevy of professionals will attain over the years to come and accepts money gifts from reunion classes whose members have bewildered the I.R.S. The class of 1924 was represented only by **Don Fife**, **Del Kendall**, and **Russ Ambach**. The latter missed the speakers' program, the president's reception, and the class secretaries' sherry party because of limited physical ability. However, the three of us attended the Technology Day luncheon, and Don made the reception.

Don Moore has settled in California at 20 East Main St., Apt. 25, Los Gatos 95032, phone (408) 354-7516. . . . **Dick Shea** has rooted in Florida at 6404 21st Ave., Brandenton 34209, phone (813) 795-0756.

Susan Pope, daughter of **Edgar Bilton** reports his death on February 2, 1988, in New York. Ed had been in poor health for some years. At one time, he was a C.P.A. with Haskins & Sells, Inc.

Your secretary has to move in the future, as his original retirement home, Rogerson House, Boston, will be redeveloped. The modern apartment style will not be suitable for elderly living.—**Russ Ambach**, Secretary, 434 Jamaica Way, Boston, MA 02130; **Rock Hereford**, Co-secretary, Hacienda Carmel No. 90, Box 5397, Carmel, CA 93921, (408) 625-7590

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Courtenay Worthington, **Stanley Lane**, **Sam Spiker**, and your secretary attended Technology Day last June and all got together at the luncheon. A card was received from **Charles Peterson**. He and Ruth have been traveling in Europe. Charles is an architect, and he noted that he was about 60 years late in seeing firsthand how they build in Europe.

Milt Salzman writes with some ideas for the observance of the 65th class reunion. He continues his activities in barbershop singing and attended the International Convention in San Antonio, Tex., in July. It was the 50th anniversary celebration of SPEBSQSA, of which Milt has been a member for 27 years.

Milt recently returned from a European trip where he visited his son Roy, '55. Together with Roy and his wife, Milt drove to Reinfeld, West

Germany, to join in a family reunion of a branch of his mother's family.

A telephone call from Michael Symonds brought the information that his mother, Virginia, widow of **Irving Symonds** had passed away at her home in San Antonio, Tex., on June 7, 1988. Virginia had been in failing health for several years.

It is my sad duty to report the passing of six classmates. **Lynn Wetherill** died on April 22, 1988, at the Berkshire Medical Center in Pittsfield, Mass. As a VI-A student, Lynn did his cooperative work with General Electric, and, upon graduation in 1926, he went to work full time with that company in Schenectady. In 1928, he was transferred to Pittsfield. In 1934, he went with the former high voltage bushing engineering division. In 1952, he was appointed manager of engineering for the newly-established power transformer department. From 1964 to his retirement in April 1966, he was consulting engineer in the department. Following his retirement, he was a consultant to GE. Lynn is listed in *Who's Who in Engineering* and was one of seven engineers cited in 1965 by the Massachusetts Society of Professional Engineers for "outstanding service" to the engineering profession. He was the chairman of the state Board of Registration of Professional Engineers and Land Surveyors for 12 years; a member, former director, and past president of the Berkshire Hills Country Club; and he enjoyed nine holes of golf regularly until his recent illness. He was a member of the Elfun Society, the Stanley Club, and the American Institute of Electrical Engineers of Berkshire County, of which he served as chairman. In 1969, Lynn was named by then Mayor Donald G. Butler as chairman of the Road Reconstruction Commission, which rebuilt a number of major city roads that were in bad condition. He also served as a member and chairman of the Pittsfield High School Technical Department Advisory Committee in the 1950s. Lynn leaves his wife, the former Irene Messier, four brothers, two sisters, and three grandchildren.

Lloyd W. Irving passed away in Detroit on April 4, 1988. Lloyd went with Goodyear Tire and Rubber Co. following graduation and later worked for Firestone Co. He is survived by his wife, three daughters, and a sister.

James C. Evans died of Alzheimer's disease at his home in Washington, D.C., on April 14, 1988. Jim worked on efforts to integrate the armed forces in the 1940s and was an aide to the Secretary of the Army. Later, he was an assistant in the Defense Department's Office for Manpower. From 1946 to 1970, he taught electrical engineering at Howard University. He is survived by a daughter, a son, a brother, and four grandchildren.

Belatedly, the news of the passing of **Edwin L. Wildner** has reached alumni headquarters. Ed died on June 13, 1987, at his home in Newport News, Va. . . . **Calvin A. Campbell** died on April 20, 1988, in Midland, Mich., and **James A. Holland** passed away on March 20, 1988, in Peninsula, Ohio.—**F. Leroy Foster**, Secretary, 434 Old Corners Rd., P.O. Box 331, North Chatham, MA 02650

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We just had our Technology Day June 3. The talks were excellent, and you can probably read about them in the *Review*. We didn't have as many classmates show up as we would have liked. I had a very interesting talk with a man from the class of 1918. Our president **Robert T. Dawes** and Evelyn, **Robert C. Dean** and wife Ruth class of '29, and Ruth and **Ben Margolin** were all interesting tablemates. **Elton E. Staple** was also there, but because his table was some distance away, we didn't have the pleasure of his company until later. Hanging overhead was the twin "Daedalus," the M.I.T. human-powered aircraft that set three records April 23 in a 3-hour,



The sharp-eyed members of the Class of '26 doubtless know that the avid crew supporter identified as "Malcolm Greer" on page MIT 23 of the Aug/Sept Technology Review is none other than Mark Greer, '26 (above left), on hand to dedicate a new shell. Boy, are we embarrassed!—Ed.

54-minute flight over the Aegean Sea between the Greek island of Crete and Santorini, a total of 74 miles. Details are in the *Review*, (August/September 1988, p. MIT 17.) Two days later was the Cardinal and Grey Society Luncheon and meeting at Endicott House in Dedham, Mass., a beautiful estate left to Tech. The society is for those who left Tech 50 years ago or more. C. Marvin Pickett, Jr., and a beautiful girlfriend attended. We always have a worthwhile talk by one of our professors. . . . When I was at Washington's Crossing in Pennsylvania in May, I called Pink Salmon and have received a letter from him. He had just sent the finances of our class to Tech. Pink and Mary could not be at our 60th due to Mary's cancer. "She spent some time in the hospital in 1986 and '87, but is quite fully recovered now." Pink wants to be remembered to all of you. They left Hingham, Mass., years ago and he is active in a retirement complex in Newtown, Pa. . . . Henry W. Jones wrote about the picture of Mary and Millard M. Greer mentioned in the May-June Tech notes. He said they were roommates and fraternity brothers for four years.

William Baker passed away June 11, 1984. Just got the notice. He was from Scotsdale, Ariz., and was at our 50th reunion. . . . Ole M. Havaard, who was born in Denmark and became an American citizen, died in Brunswick, Maine, on August 31, 1982. He leaves his wife, Hazel. . . . Lewis C. Hutchinson of Temple, Tex., died sometime in 1986. . . . John E. Longyear of Riford, Mich., died April 20, 1987, leaving his wife, Agatha. They attended all our reunions, including our 55th. . . . Jose DeMartineo Nortiega of Mexico died October 28, 1986. . . . A. Donald Green of Mountainside, N.J., died April 26. A close friend of mine and his said he died on the golf course. When your time comes, it's better to have no long, drawn-out sickness. He had a great career in product development. As manager of Exxon Development Division, he developed the Liberty rubber plants during World War II. He was also an elected fellow of the American Association for the Advancement of Science. Along with wife, Jane, he was active in many organizations. . . . In a note from Hancock, N.H., John B. Wilber informs us that his wife, Lillian, died on June 30, 1988, following a long illness.—Donald S. Cunningham, Secretary, 27 Lowell St., Braintree, MA 02184

Lawrence W. Day in Fairfield, Conn., reminisced a few months ago about his navy ROTC flying days with the late Franklin "Hank" T. Kurt. "I roomed with Hank in Hampton Roads, Va., during six weeks of training for an ensign commission in the summer of 1926. We flew together in HSTL flying boats, which were known as hard ships to land. I had a Maxwell roadster we both enjoyed taking out on dates. In the fall we drove to Hartford to attend a coming-out party for one of Hank's girls, then drove to an army/navy football game at West Point. Those were the days!" Thanks Larry—a little nostalgia is very refreshing these days.

Eugene N. Geisel of Wellesley, Mass., died December 7, 1987. He was a University of California graduate and came to M.I.T. as a senior in electrical engineering. In 1955 he was an electrical engineer for Highway Traffic Engineers in Brookline. His widow, Josephine, continues subscribing to *Technology Review*.

John P. Engel of Franklin, N.Y., died March 21. In 1955 he was general superintendent of Sapolin Paints, Inc., in Brooklyn. He moved to Miller Place, Long Island in 1960, and then to Franklin in 1976. John leaves a large family that includes his widow, Gertrude, a son, three daughters, twelve grandchildren and five great-grandchildren.

Robert S. Hatch of Myrtle Beach, S.C., died April 17 at his home, following a lengthy illness. In 1955 he was executive vice-president of Aramco Overseas Co. in The Hague, Netherlands. Bob retired to Myrtle Beach in 1965 and is survived by his widow, Rufina Ann, son, Robert Jr., and daughter Janet.



Larry Cheney

Laurence B. Cheney of Greenwich, Conn., died March 25. He retired from UniRoyal in 1968 in Naugatuck, where he had been an engineer since 1938. Larry was a retired colonel in the U.S. Army Reserve and served in World War II. He was a former deacon of First Church Congregational, and was active in the local Sea Scouts program in the Old Greenwich Boating Association. Larry was well known as a teacher of antique stenciling, country painting, and furniture restoration with caning and rushwork, having taught adult education classes in Greenwich for many years. He was a member of the Society of American Decoration, and gave a one-man exhibit of his work in Greenwich in 1987. Quite a record for a civil engineer, but very typical of M.I.T. retirees who devote time and energy to their communities. Larry could be proud of his grandson—Jonathan Connell, S.B. '83, M.S. '85, Ph.D. '88 Course VI.

We send our sympathy to the widows and families of these classmates.—Joseph C. Burley, Secretary, RFD 1, Epping, NH 03042; Lawrence B. Grew, Assistant Secretary, 21 Yowago Ave., Branford, CT 06405

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It was Anne Palo who exclaimed with enthusiasm: "The '28 family has gathered!" How nicely spoken and so appropriate as our 60th re-

union got underway Wednesday, June 1, 1988, on campus. All of us were housed at gracious McCormick Hall for the five-day period. No one opted for a hotel room; this made for a more cohesive party and homier atmosphere. It also helped greatly in getting scheduled events started on time. (See photo, pages MIT 28-29.)

Our reunion was a resounding success! For a class of our age, we had what must have been a record attendance: 96 in total, consisting of 50 classmates, 27 spouses, 9 widows and 10 guests. All but a very few went the full program distance—and with little or no apparent strain. Classmates came from all parts of the country and some from more distant points abroad. To our best knowledge, all returned safely home.

After checking in, each arrival was cordially greeted in the Country Kitchen of McCormick and offered an attractive selection of refreshments. This hospitality service was presented by Frannie (Mrs. James) Donovan as a tribute in memory of Jim. She was ably assisted by Dorothy Goldberg with further help and contributions from others of the '28 widows group. The buzz and excitement of so many old friends meeting once again and busily conversing was both impressive and heartwarming. For our first evening together, we had the now traditional Bill Carlisle Cocktail Hour followed by a very fine dinner—all at McCormick. A class business meeting and election, as scheduled by Chairman Abe Woolf, was held immediately afterward. Those elected were: Walter Smith, president and secretary; George Palo, vice-president and treasurer; Ernest Knight, vice-president and assistant secretary. The nominating committee consisted of Hermon Swartz (chairman), Morris Klegerman, and Harlan Paige.

Our first full day, Thursday, was indeed full. Shortly after breakfast we boarded buses for Boston. A brief stop was made at Killian Court where a group photograph was taken in panorama and color with our much-loved great dome and columns in the background. It turned out to be a beautiful shot; all the cardinal red jackets against the fresh green of trees and lawn made it a truly gorgeous sight! Then it was on to the Prudential Center, where we were greeted and escorted to the top of the tower to see Boston, Cambridge, and surrounding areas from on high. It was not a bright day but plenty clear enough to give us very good viewing. We had a special festive lunch at the Back Bay Executive Club on a lower floor in the tower.

That evening was M.I.T. Night at Boston Pops, where we enjoyed a fine concert conducted by John Williams. The violin soloist was especially outstanding. Friday was Technology Day, and we joined in the general activities of the day. These began with a memorial service in the morning followed by a program of speakers in Kresge Auditorium on the general theme of "Materials, Productivity, and National Well-Being." Technology Day luncheon, served in the Athletic Center, was the occasion for awards and presentation of class gifts (including our own 60th). We also joined in the all-Tech social hour that afternoon.

The day was topped off with a very special lobster dinner served in the Faculty Club. Here a note of nostalgia was introduced by presenting each diner with a commemorative stein reminiscent of such practice many years ago. Of course, beer was served with the lobster (else, why a stein?). Priscilla and Paul Gray, '54, were our guests for that evening, as well as "Doc" Edgerton (honorary member) and Mrs. Edgerton. In speaking briefly to us, Paul expressed recognition and appreciation for the way older classes have contributed to the growth and success of M.I.T. Despite a balky projector and some very old movie film, we did manage to get some glimpses of '28 reunions of years long gone by. The rest of the evening was given over to lighthearted fun. Two, having birthdays of the date, were discovered: Jo Shiepe and Marge Puschin. They were properly recognized and serenaded. Travelers who came farthest for the reunion were Miriam

and **Cliff Terry** from Hawaii. The oldest attendee, at 90 (and document equipped), was **Tom Larson**. Tom shows very little physical evidence of his age. He even boasts a full head of hair that is only slightly gray. He enjoyed having the ladies test its authenticity by tugging at it. Apparently they enjoyed it too. Spontaneous singing, characterized mostly by its enthusiasm, erupted periodically during the evening with **Jim McCarthy's** corner doing its full share. Later, back at McCormick, the spirit continued with **George Mangurian** at the piano and Jim still setting the vocal pace.

Saturday was our busiest day with still plenty of vim left in the group. We traveled by bus to Endicott House in Dedham where, in elegance and beauty of environment, we enjoyed lunch and a highly informative talk on *Ramesses II*, the great Egyptian pharaoh, whose fabulous treasures were then on display in Boston. That evening we saw the exhibit itself in the Boston Museum of Science. It was indeed impressive but a bit too crowded for comfort. We also attended the show called "Seasons" in the museum's Omni Theater; it was both beautiful and dramatic. An excellent dinner in the Skyline Room atop the museum gave us a near perfect conclusion to the evening. We were treated to the glorious spectacle of Boston, across the Charles River, bathed and flashing in a golden sunset. This faded and was soon followed by a different but equally impressive sight of the city illuminated at night. An "open mike" was made available so that everyone was given the opportunity to "speak his piece" and many did just that. Sunday, after brunch, was farewell and departure time with many vowing to be back for the 65th!

With deep regret, we must now report four class-related deaths. **Howard R. Batchelder** died April 20, 1988, at a nursing home. The information came to us with a note from his wife, Christina. Howard graduated in Course V, chemistry, then continued his studies to obtain his S.M. degree in that same department. Much of his professional work was in fuel and chemical industries related to coal, gas, and oil. In later years, he was associated with Battelle Memorial Institute. The Batchelders had two daughters and six grandchildren.

Richard N. Palmer died May 16, 1988. A newsclipping brought the information to our attention. Richard came to M.I.T. as a graduate student and received his S.M. in chemical engineering. During World War II years, he was engaged in the Manhattan District Project. His wife, Eunice, survives him.

Hugh B. Spalding died March 25, 1988. We were informed of this in a note from his son, Philip. Hugh received his S.M. in chemical engineering, and he followed that profession in England during most of his life. Hugh became widowed in 1975. . . . In a note from Hancock, N.H., our honorary class member, **John B. Wilbur**, '26, informs us that his wife, Lillian, died on June 30, 1988, following a long illness. They had been invited to participate in our reunion celebration but had to decline. . . . To the families of these classmates we extend our heartfelt sympathy.—**Walter J. Smith**, Secretary, 37 Dix St., Winchester, MA 01890; **Ernest H. Knight**, Assistant Secretary, Raymond, ME 04071

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Adrian "Cub" Clark of Woodbury, Conn., writes about his activities since graduation: "There were not a great number of choice jobs available in 1929, so I took a job with Sears "B" stores in Brookline, Mass. After six months, I went back to M.I.T. for my S.M. in fuel and gas engineering and took a job with the Utilization Laboratory of Consolidated Edison of N.Y. I married Hope James (Emerson College), have one son (Brown University), and three grandchildren (12, 15, and 17, the latter entering Boston University this fall). I have a brother, **Waldo B. Clark**, M.I.T./Harvard

'19, who is 90 years old.

In 1936, I was loaned to Good Housekeeping Institute, another laboratory. I quit in 1940 and went to work for Van Nostrand Co., Inc., book publishers, as vice-president and editor. (Tubby Rogers would have approved.) The next 20 years were challenging and fascinating—lots of desk work, long hours, starting books, and working with remarkable scholars like John Von Neumann, Samuel Glasstone, Marshall Stone, John Kemeny, and Paul Halmos. Series of books were developed. In 1958, I went to Geneva as an official press representative to attend the Second International Conference on the Peaceful Uses of Atomic Energy.

"In the early sixties, we had some health problems, but fortunately nothing serious developed from it. I retired shortly thereafter but remained a consultant for three more years. We settled in Connecticut where we had been vacationing in the past on and off. Hope and I have busy days. She has a way with kids in the junior church choir, plays the piano, is a volunteer entertainment producer in the Lutheran Home. I as a teacher's aide with first grade, using an Apple II computer. We do enjoy our life here in the hills of Bethlehem, Litchfield County."

John Happel of Hastings On Hudson, N.Y. writes, "Life has been good to me. A group of former students arranged for a celebration of my 80th birthday. About 80-90 people were present, many former doctorate students at New York University. The party was organized by my former student, Howard Brenner, now Willard Dow Professor of Chemical Engineering at M.I.T.

"As for family, I have three fine children, none married, so I don't know about grandchildren. One unfortunate thing happened recently. In late February, my wife Dottie, Ruth (my youngest daughter), and I went to Guatemala for a short vacation. One item on the agenda was a trip to Tikai to explore the ancient, impressive Mayan ruins. While climbing one of the pyramids, I fell and broke two vertebrae in my neck. Luckily, a very capable neurosurgeon in Guatemala did a good job of sewing and bone grafting and put me on the road to slow recovery. It could have been much worse. For the good news, *Chemical Engineering Communications* will devote an issue to papers celebrating my 80th birthday. This summer, we are going to a catalysis congress in Alberta, where I will give a paper and we will visit Lake Louise and later Lake Placid, I hope."

Murry M. Brimberg of Silver Spring, Md., writes, "Since my retirement, we have been traveling each year pursuing volunteer activity. We have been to Israel, London, Florida, and visiting our children on the East Coast. Three of our four grandchildren are now attending college, one at Haverford, two at Harvard, and the fourth will be on his way to M.I.T. soon. Our daughter and son-in-law are fully occupied in the medical field, practice research, and travel pretty much around the globe for meetings, delivering papers and teaching. Thank the Lord, Mary and I are still able to get around, attend our many organizations, and look forward to seeing our classmates at the 60th reunion next year."

Richard E. Bolton of Canada, writes, "My wife, Betty, is very much weaker and can no longer speak. It is very sad because we were a devoted couple and enjoyed a wonderful life together. Our daughter, Pamela (Angus), is arriving tomorrow to see her mother and also to cheer me up. I am making progress in the use of Wordperfect, which should make this easier for you to read than my normal scrawl. Slowly, I am converting the text of my family history to Wordperfect format, which should reduce the cost of publication. Tradition has it that one of my maternal great grandfathers, Robert Hamilton Leathern, and his brother, Alexander Leathern, were descended from that brilliant rascal, Alexander Hamilton. Indeed, the name Hamilton has been used in five of the last six generations of our family. So far, I have been unable to establish exact connection, so there is still some more digging to do.

"I was in Britain for a couple of weeks last spring (1987). Once again, I felt the urge to get a new pair of shoes from a firm on Cork Street, London. As one can't cross the Atlantic for a pair of shoes and still be considered sane, I decided to visit Edinburgh again and also see how the restoration work was progressing in York Minster before spending a few days with the cousins in Bristol and London. It worked out very well, and I returned home much refreshed. I have no plans for this spring and summer, and expect I should stay very close to home, for obvious reasons."

I regret to announce the deaths of the following members of our class: **Richard Oppen** of Wolcott, Conn., February 15, 1988; **Charles Frank, Jr.**, of Waltham, Mass., March 9, 1988; and **Lt. Col. Laurence R. Moses** of Sarasota, Fla., June 9, 1988.

Richard Oppen, who attended our 50th reunion, was a chemical engineer who worked for Uniroyal for 43 years before his retirement in 1973. He was a member of the American Chemical Society and past president of Naugatuck YMCA, Walcott Historical Society, and the Industrial Development Commission of Walcott. He is survived by two cousins.

We received a note from Larry Moses' wife, Kay, as follows: "It is my sad duty to write and tell you of the death of my darling Larry on June 9. He was the strongest of men, for he fought the good fight for seven years. Along with the rare disease amyloidosis, he had numerous other unusual diseases, so he was constantly in and out of the hospital these last 14 months. He is now at peace, but oh how I miss him! His smile so constant even in pain. Sorry to have to send such a sad note."

Upon graduation, Larry joined the New York Telephone Co., worked for 40 years and retired. He served in World War II as a lieutenant colonel. He was a member of the Palms Presbyterian Church, Sigma Chi Fraternity, AARP, and Retired Officers Association. He also belonged to the Village Green Golf Club and the Memorial Hospital Auxiliary. Survivors include his wife, Katherine V.L.; a daughter, Katherine Hubbard of Burlington, N.C.; two sons, Col. Laurence G. of Heidelberg, West Germany, and William V.L. of Hamlin, N.Y.

My wife, Helen, and I got acquainted with Larry during the 50th reunion at the Cape. Kay was unable to attend, so we were together in a cottage along with **Robert Pride** and wife Marion, **Hunter Rouse** and his wife, Doi, and a few others. We found him to be a friendly, considerate, and loyal classmate. Through the years, we developed a close relationship, and he always sent me news of himself and family in reply to my sending a birthday greeting. At the reunion, he talked about his wife, Kay, (I don't recall the reason for her not attending) and remarked, "you will like her when you meet her," as we mentioned that we might get together while we were in Florida in the winter. This episode will remain a great disappointment to me and my wife for not carrying out our plan.

Do not stand at my grave and weep,
I am not there; I do not sleep.
I am a thousand winds that blow,
I am the diamond glints on snow,
I am the sun on ripened grain,
I am the gentle autumn rain.
When you wake in morning's hush,
I am the swift uplifting rush
Of quiet birds in circled flight.
I am the stars that shine at night.
Do not stand at my grave and cry,
I am not there; I did not die.

—**Karnig S. Dinjian**, Secretary, P.O. Box 83, Arlington, MA 02174

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With the passage of time, our classmates are acquiring increasing numbers of great-grandchildren. This month's "g.g.c. report":

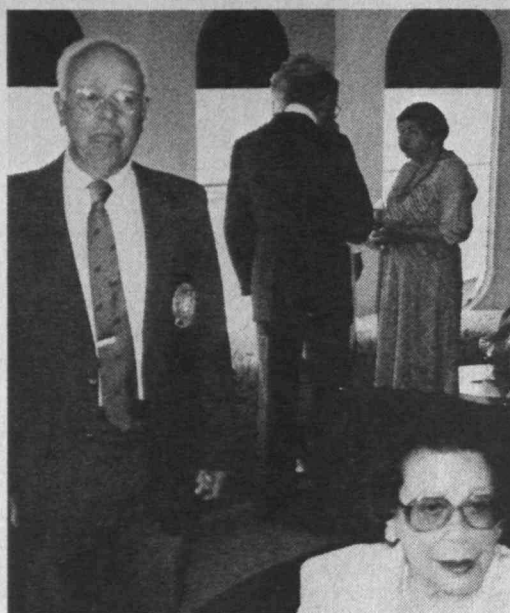
Evelyn and Dick Phillips have twin great-granddaughters; **Charles Prichard** has two great-grandsons; **Robert Quinlan** has seven great-grandchildren, which may be a record. Can any of you top seven? . . . The Phillips still live in Old Greenwich, Conn., and list as their hobbies: fishing, gardening, golf, travel, and financial markets. . . . **Charley Prichard** is "coping with old age," i.e. although legally blind, he lives alone in a retirement community apartment in Nashua, N.H. . . . **Bob Quinlan** is a security officer in the Atlanta area, attends meetings of the local AARP chapter and Masonic Club and lives in East Point, Ga.

Al Bird writes from Rockport, Maine, that he is "enjoying the Penobscot Bay region with summer sailing, fall foliage, spring maple syrup, new flowers—quality of life is good here." . . . **Adolph Hugin's** career as an engineer, inventor, law school teacher, and patent lawyer as well as his participation in many civic, social, and religious organizations, have been previously reported. He has now retired, lives in North Springfield, Va., and apparently is in good health. He says his time is now spent "largely finding and growing things like flowers, grasses, and shrubs, but it is not always easy in this famous red Virginia brick clay. But I try and at times get remarkable results. Other than that, I keep active in charitable works.

Reports came in this month from two of our armed services retirees: **Angelo "Ric" Ricciardelli**, who retired from active duty as a colonel in July 1963 and **Joe Rehler**, who retired as a captain, Civil Engineer Corps, U. S. Navy, in January 1970. Both have had active post-retirement careers. Ric retired for the second time in 1986 after completing 17 years as a civil service employee of the U.S. Army Foreign Science and Technology Center in Charlottesville, Va. At the time of his second retirement, he was chief of the Electronics Division. Ric reads Italian literature in the original and put his knowledge of Italian to good use last summer during a month's visit to Siena. He is also involved in "Reading for the Blind." . . . Joe Rehler's service career took him to many parts of the world, and his report contains reminiscences about the "all expense tours" the navy provided for him, scary aircraft takeoffs and landings at primitive airfields, living and/or traveling in Paris, Stuttgart, Greece, Rome, Holland, Belgium, and Denmark, and, above all, "the beauty of Japan particularly during the cherry blossom season, and our contacts with the Japanese people during the two years we lived there." In his second career Joe has been a consulting sanitary engineer and his retirement home is in Portsmouth, N.H.

We have received notices concerning the deaths of three more of our classmates: **Allen Shepherd** last April 10, **Bob Reynolds** on April 30, and **Dave Landen** on May 26. . . . After graduating from M.I.T. **Allen Shepherd** did some graduate work at the Institute and at the Columbia School of Mines, then worked for a time at Bell Labs. Thereafter, he worked as a materials engineer for the Hancock Valve Division of Manning, Maxwell & Moore, as chief metallurgist of Bostitch, Inc., and senior metallurgist of Textron, Inc. Upon retiring in 1969, he continued to do metallurgical consulting work for clients such as Cottrell Co., Mossberg-Hubbard, the Foxboro Co., Madison Industries, Inc., and Equipos y Controles Industriales of Bogota, Columbia. In recent years, he taught metallurgy at Roger Williams College and gave lectures and courses of instruction before technical societies, industrial firms and at Brown University, the Rhode Island School of Design and Rhode Island College. He was past state chairman and honorary life member of the Rhode Island chapter, American Society of Metals, a coporator of the Woonsocket Hospital, and former chairman and ten-year member of the North Smithfield Zoning Board of Review. He is survived by a son Allen G. Shepherd III, and two granddaughters.

Bob Reynolds died after a long illness in Centerville, Mass., where he had lived since his first



It happened somewhere between St. Louis and New Orleans—socializing and renewed acquaintances—when members of the Class of 1931 and guests celebrated a mini-reunion



above the Mississippi Queen. Above left: Helen Worden (background); Dick Ashenden and Charlotte Shulkin (foreground). Right: Polly and Ken Germeshausen.

retirement in 1973. At the institute he was managing editor of *Voodoo*, president of the Sigma Nu chapter, and a member of the varsity mile relay team. Most of his career was spent in the advertising field. In the 1930s, he worked as a creative account executive for the J. Sterling Getchell Agency, where his magazine advertising campaign for Socony-Vacuum Oil Co. won the annual first place award of the National Industrial Advertising Association. During these years, **Charlie Ladd**, he, and I used to meet occasionally for lunch.

Moving to the Boston area in 1948 with the Sutherland, Abbott agency, he subsequently became president of his own agency, Reynolds & Foster. After retiring to Cape Cod in 1973, he embarked on a new career with Packaging Industries of Hyannis, from which he re-retired in 1977. His club and professional associations included the Winchester Country Club, Broadcasting Executives Club of Boston, Advertising Club of Boston, past president of the N.E. Chapter of the American Marketing Association, Wianno Club, Oyster Harbors Club, U.S. Power Squadron, member of the Barnstable Republican Town Committee and the Barnstable Economic Development Commission.

Bob is survived by his wife Cynthia, a son Robert Wood Reynolds, Jr., of Acton, Mass., a daughter, Marjorie Wright of London, England, and four grandchildren. Several years ago he called my attention to the fact that the Reynolds family, like the Joe Harrington family, has had a long association with M.I.T. His grandson, Robert Wood Reynolds III, has a quadruple M.I.T. ancestry, i.e. two grandfathers and two great grandfathers who graduated from the institute.

Dave Landen worked for the U.S. Geological Survey throughout his career, starting as a field assistant in 1932 and rising through various grades to research civil engineer of the staff of the Topographical Division in Reston, Va. His field of expertise was the application of aerial surveys to topographical and geological mapping and research on photogrammatic mapping. Among his accomplishments was the development of a system of topographical mapping used by eight countries in mapping Antarctica. In

recognition of this contribution, he had a mountain named after him. Mt. David Landen is on the Cole Peninsula in Antarctica. During World War II, he was chief instructor at the U.S. Air Force School of Phototopography at Lowry Field, Colo. After his retirement from U.S.G.S., in 1974 he became an associate professorial lecturer at George Washington University, teaching cartography and photographic interpretation. He was a registered professional engineer D.C., honorary member of the American Society of Cartographers, life member of the American Society of Photogrammetry, co-author of the *Multi-lingual Directory of Photogrammetry*, editor-in-chief of the *Manual of Remote Sensing* published by A.S.P. in 1975. Dave is survived by his wife Jeanne, a daughter Deborah and son James, both of whom are medical doctors, and two grandchildren.—**Gordon K. Lister**, Secretary, 294B Heritage Village, Southbury, CT 06488

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Thanks to Polly Germeshausen, the recent mini-reunion on the *Mississippi Queen* from St. Louis to New Orleans was a big success. The following persons attended: Margaret and **Richard Ashenden**, Mary and **Eugene Branca**, Pauline and **Keneth Germeshausen**, Constance and **Henry Hartwell**, Marcella and **Richard Kropf**, Pamela and **Robert Martin**, Adrienne Radzwiller, Evelyn and **Howard Richardson**, Emily and **Robert Sanders**, Charlotte and **Ben Shulkin**, Lillian and **Albert Sims**, Clifton A. Smith, Marie and **Allen Wilson**, Helen and **Edwin Worden**, Edith Seltzer, and Alice and **Arthur Lutz**.

Dick Ashenden gave a talk on the plans for the next reunion—we will probably stick to Cambridge. Also, **Howard Richardson** said **Randy Binner** was absent because of a previous engagement to attend his wife's college reunion.

We must report the following deaths. **Robert Parker**, 318 Haverhill St., N. Reading, MA 01864, died April 23, 1988. He leaves his wife, Margaret. . . . **Howard J. Wood**, Louisville, Ky., died March 14, 1988. . . . **Julian P. Hastings**, Framingham, Mass., died September 28, 1987. . . . **Gor-**



"Our reunion was a resounding success," says Walter Smith, Class of 1928 secretary, and it inspired one of his best columns yet (see page MIT 25).

don A. Speedie, Danvers, Mass., died February 17, 1988. . . . Charles O. Terwilliger, Jr., 4848 Sage Dr., Laramie, WY 82070. He leaves his wife.

Our sincere condolences to the relatives of the above.—Edwin S. Worden, Secretary, P.O. Box 1241, Mt. Dora, FL 32757; John Swanton, Assistant Secretary, 27 George St., Newton, MA 02158

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John Strickler, Sr., and his wife have been living for over 20 years in a home that is heated by a nuclear reactor—the sun. With the aid of good insulation, he keeps his electrical heating bill to \$60 per year. John sells his plans for the house, called EVAC, for \$150. In 1981, the 1,536 square-foot home cost about \$25 per square foot, complete with carpets, appliances, etc. Through arranged tours over a four-year period, about 1,800 people came to see EVAC.

There is much more to his story—technical, economical, and human interest. If you would like to know more, write to him at: 339 N. Wind Sun Way, Camano Island, WA 98292. You will like what he sends you. More about him personally will appear in the next issue.

Arthur Marshall is a fine example of how to squeeze the most out of time. He writes: "In March, we went on a three-week trip to Russia, Finland, Denmark, and Iceland. In April, we were in Israel for two weeks, and next week (June 16), I'm going to Israel sans wife for three weeks. We plan to spend about three weeks at the Olympics in Korea with a brother-in-law and in November three weeks in Rio de Janeiro and the Antarctic. After that, if I survive the running around, I plan to stay put for a while. I'm looking forward to our 60th reunion in 1992. I send my warm personal greeting to you and to all our '32 classmates. As our numbers decrease, let's try to get together as often as we can." Incidentally,

the Marshalls have six grandchildren and three great-grandchildren. Can anyone top that?

Robert B. Thompson, 11 Factory Cove, Boothbay Harbor, Maine, writes a warm friendly letter. He says, "My wife of 51 years, Lovola, and I still enjoy good health. We live an extremely quiet life here on the Maine coast but always enjoy visitors. You probably don't remember me at Tech, but I have a very clear picture of you. During my last two academic years, I was cashier at Walker dining hall for the evening meal. I recall that you were one of the regular customers and, I particularly remember your warm and ready smile as you paid your bill. I guess I didn't get too many smiles at that job, but yours stood out. I hope you still have it. Best regards and thanks again for a job well done!"

On Technology Day, June 3, 1988, these classmates were present: William Bannon, Wendell Bearce, Don Brookfield, John Brown, Melvin Castleman, Oscar Marzke, Al Dietz, William Pearce, Charles Tayol, Thomas Weston.

Our class president conducted a short meeting. He informed us that Gaynor Landsdorf, our class estate secretary, died. He was vice-president of Standard Oil of California and was very active on the West Coast. Wendell Bearce was nominated for the estate secretary post. He will give the matter serious thought and make a decision in the fall.

William Pearce, our treasurer reported that, after paying all bills, the class has \$2,400 in the bank. Ed McLaughlin, our class agent, will start "cheerleading" the 60th reunion gift in future class agent letters. We have 288 active members in our class.

There was a memorial service of M.I.T. Alumni at the M.I.T. chapel. Those who passed away in the past year from the class of 1932 are: Winston B. Braxton, Libero F. Cappabianca, John P. Coogan, Donald B. Gilman, Lester Glickman, W. Penn-Gaskel Hall, Jr., David D. Kiley, George E. Murray, John Navas, David R. Pryde, Thomas B. Rhines, F. Carlyle Roberts, Jr., George H. Sistare, Jr., Rev. George H. Smith.—Melvin Castleman, Secretary, 163 Beach Bluff Ave., Swampscott, MA

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Should you wonder at the time lag of reports in these class columns, be advised that the lead

time between copy deadline and magazine mailing approximates 90 days. By now you should have received, in fact a long time ago, a letter to all classmates concerning the 55th reunion and other relevant matters. For those who missed it, be advised that the newly-elected (or re-elected) officers are: president—Dick Fossett; vice-presidents—Steve Rhodes, Fred Johnson, Don Fink, and Bob White; secretary—Bill Klee; treasurer—Burt Webster; and class agent—Herb Grier.

Bill Harper of Hattiesburg, Miss., has spent a lifetime in the chiropractic field and is going to reach 100 years of age whilst drinking gallons and smoking chimneys daily. . . . Walter Vernon Skees, retired registered surveyor of Florida, now lives in Barcelona, Spain. He's having back trouble. He says the Barcelona area, where he has been about ten years in an office/apartment downtown, is a "modern but ancient capital of three million with the most for the dollar." His phone is 011 34-3-329-8454 (AM-USA), meaning phone in the morning. . . . John King of Cleveland, Ohio, reports inability to attend the reunion because of ocular difficulties (in May). We trust he has improved.

E. C. Henderson, Jr., Webster Groves, Mo., reported in late March his inability to attend and his deep regret. . . . Don Fink, Summers, N.Y., did attend the reunion. He is currently director emeritus, IEEE, prior to which he was its executive director and general manager, prior to which vice-president and director of research, Philco, prior to which editor-in-chief *Electronics* magazine, prior to which Office of Secretary of War, prior to which Radiation Lab, Loran Division, prior to which McGraw-Hill, prior to which faculty M.I.T.

Bill Baur spends summers in Havertown, Pa., and winters in Dunedin, Fla. . . . Pat Amenta, of Middletown, Conn., attended the reunion and recalled, for all of us to enjoy, memories of the '33 M.I.T. basketball team—10 wins, 2 losses. He's still enjoying college through the Elderhostel programs.

Please send your secretary any information about you or your children so we can retain or renew the friendships important to us.

Now for the sad news, the obituaries: Frank J. Lopker, 9227 Gainford St., Downey, CA 90240, died April 7, 1988 (widow Julia M.). . . . F. Lawton Barrows, D.D.S., died last May 14, 46 Main St., Middleboro, MA 02346 (widow Mrs.



Elisabeth).

After this column's deadline, we received word that **Dick Morse** died suddenly at home on July 1. He leaves his wife, Marian, 193 Winding River Rd., Wellesley, MA 02181. There will be more details in the next issue.—**William B. Klee**, Secretary, Box 7725, Hilton Head Island, SC 29938

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I am sorry that these notes are appearing so long after the events were reported. Unfortunately, Bob's leaving for Europe with his new wife and a problem back, the arrival of news for insertion in the *Review*, and my wife's death all happened about the same time.

This will be largely a sad column because of the number of deaths to report, including that of my wife of 46 years. She had an apparently successful cancer operation in 1961 and was well and lived a very full life until the summer of 1987 but then gradually began going downhill. Our mini-reunion at Skytop was one of the last little trips we made. After 17 days in the hospital, she passed away on April 26.

A letter from Mrs. **W. W. Bentley, Jr.**, informed us of the death of her husband. He was an aeronautical graduate and worked most of his 40-year career as a systems program manager at Wright-Patterson Air Force Base at Dayton. He retired in 1973 and moved to La Jolla, Calif. He is survived by two daughters, as well as his wife.

William W. Buttmi died last December in St. Petersburg, Fla. . . . From the Trust Department of the Bank of New York, we learn that **John B. Dunning** passed away November 4, 1987. . . . A news clipping tells of the successful career of **Kendal C. Ham** who was in the beverage business; first under the aegis of Pepsi and then with a company he founded in Conway, N.H. He was active in several Masonic bodies and is survived by a daughter and granddaughter.

Some of us may have known **Henry J. Joyal** who graduated from the University of N.H., but did graduate work in electrical engineering at the Institute. He appears to have had his entire career with Raytheon, passing away in Manchester, N.H., in January 1988. . . . A news clipping tells of the sudden death of **Lee J. Rusling**, whose home was in Rochester, N.Y., where he founded an investment counseling firm. He is

survived by two sons, his wife, and nine grandchildren. . . . The architects will remember **Aldo Minotti**, who served as a major in World War II and then ran his own architectural firm in Waltham, Mass., until he retired in 1980 and moved to Florida. He passed away last February leaving numerous relatives.

There is quite a bit of good news from our friends who are leading busy or restful lives. **Walter Hoffman** and his wife of 52 years have just returned from Singapore and northern Sumatra, where he visited a truly modern city hewn out of the Indonesian jungle. Walt was involved with a large world-class natural gas liquefaction plant that was run by Mobil Oil. He was impressed with Singapore, which is a bargain shoppers' paradise. . . . **Harold Leighton** describes life nearer home, where he summers on the Maine coast and takes trips with senior citizens of Hamilton, Ohio. His daughter is town clerk of Brewster, N.Y. . . . **Frank Moore** describes a 50th anniversary party that was given for him and his wife. He points out that the eight women who were in their wedding party are all still alive, but only four of the men are living. He also describes a trip to Argentina and Paraguay, where he was very impressed by the modernity of the railroad equipment.

Walter Nisula reminisces about some of our classmates and hopes to hear from **Merlyn Richardson**. Walter attends IEEE annual meetings. After living in Spain for two years, he now attends stateside festivals and writes a bit of history. . . . **Jerome Raphael** reports a change in his business interests that seem to have resulted in travel to Central America and the South Pacific. He is still vitally interested in dam building. . . . **Philip Walker, Jr.** is living quietly in retirement in Sutton, Mass. He tells us his mother just celebrated her 100th birthday, and she is the widow of Philip Walker, '07.

Gil Lorenz regrets having missed the reunion. (Does he mean the mini-reunion at Skytop?) His wife had to have surgery at that time. They specialize in cruise travel and have recently been to the Far East, Oronoco River, and the countries through which the Danube flows.—**George G. Bull**, Assistant Secretary, 4601 N. Park Ave., Apt. 711, Chevy Chase, MD 20815; **Robert N. Franklin**, Secretary, Box 1147, Brewster, MA 02631

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Our class was represented at Technology Day activities early last June by **Leo Beckwith**, **Arthur Cohen**, **Thonet Daphne**, **Jim Eng**, **Forrest Goldsmith**, **Rush Lincoln**, **Bernie Nelson**, and **Allan Mowatt**. **Warren Seamans**, honorary class member, joined some of us at the luncheon. **Bernie** announced our plans for a mini-reunion lunch on September 29 at the famous Wayside Inn in Sudbury. In other parts of the country, **Jan and Leo Dee** hosted a '35 mini-reunion April 12 at the Palm Beach County M.I.T. Club with **Rose and Ellis Flink**, **Catherine and Bob Flood**, **Sally and Ed Helwith**, and **Marilyn and Leo Beckwith**. **Jimmy-Jean and Lars Ekwizel** had planned to attend but were unable to make it. However, **Lars** has offered to stir up a mini-reunion in the Miami area.

Both **Don Wood** and **Jack Ballard** face widely-scattered classmates in their respective Texas and Oregon/Northwestern areas but are hanging out the welcome mat for any who come close. The principal purpose of all this activity is to remind all of us that the 55th reunion is not that far off and that you should get out your calendars and mark June 6-10, 1990, to keep open for it. The 50th was a super-splendiferous time, and the 55th will be too, because we now have the experience to do it right.

Former M.I.T. oarsmen will be interested to learn that some members of the local rowing clubs and colleges have organized Community Rowing, Inc. It is a non-profit organization founded in 1985 to make the sport of rowing accessible to the general public in the Boston area. With over 450 participants, the club serves a variety of ages and skill levels. Their boathouse is located next to the MDC skating rink on Nonanton Road, Newton. Membership is \$10 per year plus charges for use of boats and lessons. If interested, call **Carolyn White** at 354-6883. They ask applicants to check with their doctors. I did and my doctor said, "You haven't rowed for 50 years, and I don't think this is the time for you to start." So I shall stick to my paper route and golf!

Incidentally, I am making progress in my plans to go West. I shall leave here driving on October 15, and one of my paper customers is going with me to share with driving and expenses. The route is being carefully planned along with **Bed**

and Breakfast overnights and visits to nearby national and state sites. My daughter Pamela and her husband, Rich Trombino, who drove over 450,000 miles (contract driving 18-wheelers across the country) in 1974-6, are road consultants. After flying cross-country many times, I plan to see closeup what was down below.

I regret having to report that two more of our '35ers have passed away. **Louis B.C. Fong** died February 11, 1988, in Arlington, Va. He was a Course VI man with me. His death was reported by his widow. . . . **Milton E. Nelson** died at Rhode Island Hospital on April 27, 1988. He was a special student with us in architecture after studying at Rhode Island School of Design and New York Beaux Arts Institute of Design. I am sending our deepest sympathy to the two widows.—**Allan Q. Mowatt**, Secretary, P.O. Box 524, Waltham, MA 02254

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Home again, home again, jiggy-jog, after two months and 8,800 miles on the road through 24 states and a bit of Canada. First let me pay tribute to my navigator and chronicler, Phoebe. Without her orderly, dated notes I would be hard put to reconstruct all our zigs and zags en route and the pleasant hospitality of so many classmates and wives, friends and relatives. Altogether we visited 25 '36ers and talked with seven more by telephone.

From Charlotte, where the last issue of notes left off, we continued north to Washington, D.C., where I saw **Bob Walker** and **Thelma, Henry McGrath** and **Mildred**, and **Dave Verner's** wife, Mary (I talked with Dave by telephone at his law office). Then on to New Jersey and 11 days visiting family and friends. During this interval I saw **Milner Wallace** and **Robin** in Saddle River (moving to Brookline, N.H.), talked by telephone to **Ray Woodrow's** wife, **Isabelle**, in Rossmore Village (just moved) and **Mitchell Sieminski** in Bedminster, and touched bases with Assistant Secretary **Pat Patterson** and **Marian**, and President **Alice Kimball**. Alice and Pat helped me tie classmates and incidents together. Alice will be on another cross-country trip from Labor Day to Thanksgiving—across Canada on the way out and deep southern route going back.

Heading back west, I saw **Chuck Kennedy**—seriously ill with cancer in St. Joseph's Hospital in Elmira, N.Y.; **Harry Essley** and **Elizabeth** in Rochester; **Henry Johnson** and **Dorothy** in Bloomfield Hills, Mich.; **Wayne Hazen** and **Jean** in Ann Arbor; and tried to see **Obie Falls** in Jackson. On to Illinois and **Pete Weinert** and **Jean** at Lake Barrington. **Al Musschoot** lives only a few miles from Pete, but unfortunately there was no answer when I phoned.

Now for news and anecdotes, roughly in the order of receiving them: **Ford Boulware** in San Angelo, Tex., had a major aortic aneurism repaired four years ago and a heart attack the following year, but is hale, hearty, and upbeat now—running his ranch and quarter horse-breeding farm at Christoval. Ford is still quiet and unassuming, as **Claxton Monro** remembered him our next day in Austin, and as readers of the 50th reunion biographies will sense. But I learned from wife Edith that Ford's scant reference to "World War II invasions" included leading an army battalion onto the beaches of North Africa, Sicily, Italy, and Normandy! Recently in San Angelo his headwork and chairmanship of a committee reorganized the operations of three hospitals to put them on a paying basis.

Claxton also recalled a visit from **Brent Lowe** in Houston before Clax retired as rector of St. Stephen's Church there, and his visit to Brent in La Jolla in 1985. He also visited **Aaron Loomis** in Massachusetts that year. . . . **George Cummings** in Austin had a heart valve replaced last December, yet was leaving on his third trip to the Soviet Union in May. George was with us only as a graduate student getting his master's, in between

S.B. and Ph.D. degrees at Pennsylvania State University, but he has kept in touch by contributing to, and receiving, **Bill Rousseau's** annual collection of letters from 1936 Course X-Aers, as mentioned last issue.

Charles Holman and **Lucille** welcomed us at their new home on the shore of Lake Conroe at Montgomery, Tex., and treated us royally, including a ride in their boat around much of that considerable body of water. They both continue to win honors in skeet shooting, which started for Charlie at age 50 on the suggestion of a business acquaintance. From student days he has warm recollections of **Herb Borden**, **Leonard Chandler**, **Walt Squires**, **Henry McGrath**, and **Mal Holcombe**. . . . **Gerry McMahon** recalled a summer project after freshman year when he and **Henry McGrath**, **Harry Donaldson**, and **Alice Hunter** worked with a chemistry instructor to design optimum experiments in crystallization, etc., for future freshmen classes. (They did not put a Bunsen burner under an evaporating dish of 36N HCl as I once did, to the ruin of a new corduroy suit.) Gerry's wife, Catherine, is descended from St. Margaret of Scotland, and Phoebe and I recalled our 1976 visit to her chapel in Edinburgh Castle. Gerry keeps active as Louisiana historian for the Reserve Officers Association, ham radio (KA5KVR), and other endeavors.

Although **Leo Kramer** has retired twice, from Raytheon and then from electronics consulting, he says he is busier than ever. One of his activities is painting, and we enjoyed seeing some very creditable landscapes and still lifes in his home at Palm Beach Gardens. He and **Eli Grossman** used to lunch regularly with **Spencer Meiras**, now deceased. . . . Our next stop was in Palm Beach at the home of **Bunk Knudsen** and **Florence**. He was completely recovered from a staph infection that hospitalized him last winter and required knee surgery. Bunk keeps his interest in production alive as "squire" to several young engineers in their venture to make automotive parts. He spoke of contacts with **Bob Gillette** and **Connie Bouchard** over the years, and credits Connie as an authority on rare and expensive classic cars. From the vantage of an entire career in the industry, Bunk should know.

In Boynton Beach, **Roy Thompson** and **Eleanor** live in the Pine Tree Golf Club community and play almost daily. Roy was one of our many depression-finance casualties in mid-sophomore year, and returned home to work in his father's print shop. Then, during army service in World War II, he was assigned to the Institute for nine months mechanical training and from there to Okinawa. During his later years in printing he devised a wrinkle (undisclosed), which is a considerable success.

At Marco Island on the Gulf Coast, **Gordon Thomas** and **Mary Louise** had a fine welcome for us, and Gordon had a wealth of information. The best story concerned **Larry Kanter's**, **Art Carota**, and **Gordon** at the Panama Canal during the war. Larry was called in early (1939), was assigned to the Canal Zone, and came to be G4, Coast Artillery Command, supplies and transportation. Subsequently he spotted Gordon's and Art's names on the rosters and grabbed them for his Command Staff. Came December 7, 1941, and tense times—U-Boats sinking supply ships with anti-aircraft guns aboard for canal defense, and a shipload of German planes known to have reached South America. One bomb in the right place (not the locks) could KO the canal for years. Our classmates organized a salvage operation and regained and restored some of the AAs, but tension was high for a long time. Larry met Zee, a national of Panama whose forbears had been there hundreds of years since the Spanish Inquisition, and **Gordo** and **Art** saw them married. Phoebe and I came to know Zee at reunions, and we received a lovely response after Larry died in 1978. Gordon is again playing tennis, after overcoming a back problem with special exercises, and he has a one-owner (himself) 1962 Triumph. Connie—do you read me?

This report covers only the first legs of our journey, so hang in here for subsequent issues. But if you are one of many who "have been meaning to get in touch with" **Abel**, **Baker**, **Charlie**, or whoever, may I suggest that the time is now! We are not getting any younger.—**Frank Phillips**, Secretary, 901 Los Lovatos, Santa Fe, NM 87501, (505) 9882745; **James F. Patterson**, Assistant Secretary, 170 Broadway, Pleasantville, NY 10570, (914) 769-4171

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Last June 5 **Ruth** and **Phil Peters**, their son Jeff and charming daughter-in-law Cici, Genevieve and **Leonard Seder**, **Louise** and **William Wold**, **Marjorie** and **Richard Young** and **Pearl** and **Lester Klashman** attended the spring semi-annual meeting of the Cardinal and Gray Society at M.I.T.'s Endicott House (Dedham, Mass.). We enjoyed our luncheon meeting together, heard a good speaker, and everyone seemed in relatively good spirits. The Cardinal and Gray Society is composed of alumni who have been out for more than 50 years. There were 40 alumni present and about 35 guests. Meetings are held in the spring and fall, and prominent M.I.T. staff members are guest speakers. If you are near the Boston area, I suggest you consider attending.

Frank D. Lewis, Lexington, Mass., married his wife **Beatrice** in 1945. They have two sons and one daughter. Son Peter, '75, is pursuing a doctorate in biology at Yale, where he is teaching. Peter has one daughter. On graduation, Frank became a research assistant at M.I.T. exploring microwave landing systems for the Civil Aeronautic Authority. In 1940, he transferred to the Alfred Loomis M.I.T. Radar laboratory to work on a project for the National Office of Scientific Research and Development. In May 1941, he became scientific liaison officer for the National Defense Research Committee (NDRC) in London. In January, 1943, he transferred to the Pentagon to work on the staff of **Edward Bowles**, a consultant to the Secretary of War Department. Concurrently, Frank served as a consultant to Division 15 NDRC. In November 1945, with the war over, he went with the General Radio Co. working on frequency standards, TV station monitors, and frequency measurement receivers. In 1969, he left to join the James Millen Manufacturing Co. as chief electrical engineer. In 1977, he became the chief electrical engineer for Caywood Electronics Inc., Malden, Mass., where he is still employed. He was awarded the President's Certificate of Merit in 1948 and is a recipient of the Boy Scouts of America Silver Beaver Award.

Frank writes, "R. W. Caywood, '39, and I have known each other since 1930; we were both 'hams' in Kansas City, Mo., both M.I.T. graduates and continued our close association in 'retirement jobs' together. Caywood finally retired, and I am retiring soon. I am now working on writing my memoirs of years in microwaves and the NDRC liaison with the British during World War II. In 1983, celebrated 50th-year graduation from Central Methodist College."

Rutherford Harris, Wayland, Mass., married **Jane de Olloqui** in 1942. They have one son, one daughter and four grandsons. After World War II, he joined the Arkwright Insurance Co. in their Boston home office as personnel manager. In 1955, he was promoted to be regional manager in Cleveland, Ohio. Subsequently he was appointed manager and vice-president, planning. He was president of the Alumni Club in Cleveland, chairman of the personal solicitation campaign of the M.I.T. Alumni Fund, and a member of the Fund Advisory Board. He served as chairman, Personnel Board, Town of Wayland, and vestry and warden of the local Episcopal church. He writes, "I retired at the end of 1978 and had no difficulty keeping busy with unpaid jobs, as noted above. Recent trips have been to the Yucatan Peninsula, exploring Mayan ruins, England, and Scotland with my daughter and two grandsons."

Walter O. Nygaard, Natick, Mass., married Jeanette in 1941. They have two sons, one daughter, and two granddaughters. He was a field service engineer for Combustion Engineering Inc., Windsor, Conn., and then manager of the Northeast District Power Systems Group. He retired in October, 1977. He is interested in travel, cross-country skiing, biking, golf, Kiwanis Club, AF & AM, and the Nashobi Craftsmen Club. In retirement, he also keeps busy doing yard work, house maintenance, including painting and even small roof repairs.

Walt Wojtczak, Newbury, N.H., retired in February 1986 as senior vice-president, Standard Builders, Inc., Hartford, Conn. His wife June's main interest is their retirement. Walt writes, "I keep busy with tennis, water sports, gardening, and some volunteer work, plus a little travel. Going to Hawaii next September. In September, 1987, visited the canyon country, San Diego, and Las Vegas. We spend June through October in Newbury, N.H.; November through May in Sarasota, Fla. Would be pleased to hear from any member of the class who may be traveling in our area. I do see **Howard Marshak**, who lives in Sarasota, at M.I.T. Club of Southwest Florida functions and also see **Jim Schipper**, who lives in Naples, Fla."—**Lester M. Klashman**, Secretary, 289 Elm St., Apt. 71, Medford, MA 02155

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How does one adequately describe the remarkable 50th reunion activities so meticulously planned and executed by **Dave Wadleigh** and his reunion committee for 190 classmates and spouses, most of whom attended the events both in Cambridge and on the Cape? Friday of the previous week a couple dozen classmates in our cardinal red blazers were guests of honor in the academic procession for M.I.T.'s 122nd Commencement. **Norm Leventhal** served as class marshal as we proceeded from the Student Center, along Memorial Drive, and finally through the audience of 8,000 in Killian Court where we joined our spouses in the special section reserved for us. Following the ceremonies for over 1,700 degree recipients, our spouses joined us in the recession to the applause of the new graduates and their guests as we proceeded to the special 1938 tent at the president's reception in Eastman Court. . . . Formal reunion activities started Wednesday, June 1, with registration at McCormick Hall, where most from out-of-town resided while in Cambridge. There we first saw the remarkable class reunion book published by **Horace Homer's** committee, complete with classmates' biographies, their thoughts and philosophies of life, class statistics, reminiscences in text and pictures of 1934-38 and previous reunions, and all known home and business addresses and telephone numbers for the whole class. There, too, the ladies received their lovely M.I.T. silk scarves designed originally for our class. Both books and scarves are still available.

Our first event was a private showing at the Omni Theater of the Museum of Science, followed by dinner and after-dinner remarks by David Saxon, '41, chairman of the M.I.T. Corporation. Thursday was packed with special events, the first a real treat as Margaret MacVicar, '65, dean for Undergraduate Education, shared with us the commencement address she would be giving us were we graduating in 1988 and skillfully contrasted this to the quite different environment and mores of the 1930s and 1940s.

Following the class picture in front of Kresge of classmates and spouses (by the way, a stunning color print in beautiful detail in case you have not ordered yours), we enjoyed a bus tour of the campus and luncheon at the Wiesner Building with remarks by Jerry Wiesner. The afternoon concluded with a private reception as guests of Priscilla and Paul Gray, '54, at the President's House. Buses then whisked us to Symphony Hall, where the Grays and others of the adminis-

tration joined us for cocktails and our class dinner before the traditional Tech Night at the Pops, for which we were accorded our special section on the floor.

Friday's Technology Day activities have been duly reported by the *Review*. For us the special moment was the announcement at luncheon of our 50th reunion gift by **Ed Hadley**, chairman, accompanied by our major gift chairman, **Norm Leventhal**. We can all be immensely proud of the final totals: \$4.1 million in gifts and pledges from 98.5 percent of the class with an additional \$3.39 million of known bequests and similar future provisions. Such a tribute to the donors and scores of classmates who so diligently and effectively participated in this major solicitation—about \$1 million of which was designated for student aid.

Following the Technology Day luncheon, our reunion adjourned to Cape Cod's Chatham Bars Inn. At our quinquennial business meeting the following officers were elected: chairman, **Norm Leventhal**; president, **Horace Homer**; vice-president, **Haskell Gordon**; secretary, **Dón Severance**; assistant secretary, **Ed Hadley**; treasurer, **Lou Bruneau**; and class agent, **Al Wilson**.

Although the sun made a few appearances and at times the fog came down in droplets, there was plenty of action—**Fred Kolb's** movies of previous reunions, tennis, golf, sightseeing, shopping, the Atwood House open Saturday morning specially for us. And the very special clambake Saturday evening at the Beach House. Arrangements by Sandy and **Lou Bruneau**. And speaking of Lou, his was the one name omitted in the book as an assistant editor.

Also omitted were five biographical sketches which arrived too late for publication: **Russ Coile**, **Nate Einis**, **Lloyd Ewing**, **Al Minott**, and **Russ Rossano**. Having already exceeded our allotted space, look for these in next month's notes.

In closing, friends of **Harold Cude** will be sorry to hear that he was hospitalized with a stroke about Christmas but glad to hear he was back in shape this spring.

Ed and I look forward to hearing from more of you, especially those who missed the reunion, so we can continue to have full and interesting columns.—**Don Severance**, Secretary, 39 Hampshire Rd., Wellesley, MA 02181; **G. Edwin Hadley**, Assistant Secretary, 50 Spofford Rd., Boxford, MA 01921

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Bill Wingard, chairman of the Class of 1939 50th Reunion Committee, reports a meeting held June 27 in Cambridge. **George Beesley** accepted the invitation to serve as committee co-chairman. Bill Wingard recommends placing another star in the crown of **Sid Silber** for extra work cheerfully done already for the committee. In addition to the above-named, **Fred Grant**, **Dodie Casselman**, **Ernie Kaswell**, **Joe Dana**, **Fred Schaller**, **Aaron White**, **Burns Magruder**, **Manning Morrill**, **Paul Stanton**, **Seymour Sheinkopf**, and **Bob Pratt** expected to attend. Let's respond promptly to their communications and invitations to pitch in and lend a hand.

Wes Kuhrt, who interrupted consulting and hobby woodworking to have a heart bypass, is looking forward to attending our 50th. He reports that Hewett Phillips built a model airplane based on plans for a steam-engine-powered biplane once built by Hiram Maxim, 1886, and Hewett is making wind tunnel tests on his model.

Jack Hamilton and Joan travel coast to coast and spend autumns on Cape Cod. Jack recovered after a stroke three years ago. By using a leg brace and assigning extra duties to his left hand, Jack continues to make contributions to the Rotary Club at Chillicothe, Ohio.

Bob Saunders and Sybil continue business activities in Atlanta and enjoy sailing out of their beach home at Seabrook Island, near Charleston. They plan to travel to England this summer with a group to celebrate the Church of St. Dunstan's

100th anniversary. **Dick Martin** and Natalie visited the Saunders recently in Atlanta and they all plan to attend our 50th.

Joe Zeitlen reports his retirement as professor emeritus from Technion-Israel Institute of Technology, but he continues research and consulting activities in geotechnical engineering and writing expert system programs. With four children and seven grandchildren, Joe and Frances established a new branch of Zeitlen clan in Israel.

Bob Schmucker and Jean plan to attend our 50th.

We are saddened by news of the death last November 2 at Escondido, Calif. of **Charles M. Magnuson**. Charles graduated from Yale University in 1937 and from M.I.T. in 1939. He served with the army during World War II and joined Armstrong World Industries, retiring as chief chemist in 1978. He joined the International Executive Service Corps as a volunteer and assisted with projects in Guatemala until he retired to Escondido. An enthusiastic golfer, he won the President's Club Tournament of the Escondido Country Club.—**Hal Seykota**, Secretary, 1701 Weatherswood Dr., NW, Gig Harbor, WA 98335

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Recently, I had a telephone call from **Norm Klivans**. He had spent most of the winter in Florida, returning at the end of March. He is now working part-time, playing golf, and has planted his garden. He asked about our 50th reunion, and the time in Mystic, Conn. Our reservation there at the Hilton is for the Monday, Tuesday, and Wednesday prior to commencement. We will return to Cambridge on Thursday to be on hand for Pops that evening and for the luncheon and Technology Day on Friday. The reunion committee is not fully organized, but it soon will be. Plans will be made for a program at Mystic, reservations in the dorms and at the Hyatt will be made, and all the necessary details will be covered. More information will be published as plans develop.

A note from **Agustin Cabrer** in Humacao, Puerto Rico, says, "Still at it. Someday in the near future, I will retire *partially*. I enjoy working." . . . Also from Puerto Rico, **Rafael J. Martinez** writes from San Juan, "Now that most of us in the class of '40 must be retired, there must be a lot of wandering souls coming down this way to escape the rigors of winter! I'd love to hear from anyone who ventures down here." . . . **Marshall D. McCuen** of Indianapolis, Ind., notes, "Over ten years retired, and fill time with volunteer work and travel. Visited **Rafael Martinez** in Puerto Rico in January. Interviewed ten high school student applicants this year for the Educational Council."

Bob Hess sent a note from Stamford, Conn.: "Shortly after I retired in March 1966, IBM asked me to come back to solve a problem. A few months later, they asked me again, but I refused. Found it interfered with all the things I wanted to do. Am still keeping too busy to get bored. Major activities: travel, tutoring at Stamford high school, volunteer activities, ham radio, photography, personal computer, golf. Doesn't leave too much spare time!"

I am sorry to have to report the death of **Kendall C. Valentine** of South Glastonbury, Conn., on April 2, 1988. After graduation, Kendall served in the navy, and for many years afterward in the naval reserve, retiring as a lieutenant commander. From 1957 until his retirement in 1976, he worked as a design engineer with Pratt and Whitney Aircraft of East Hartford, Conn. We extend our sympathies to his family.

Also deceased is **Marshall A. Pease** of Kensington, Conn., on February 29, 1988. He had served as an aerial mining officer in the U.S. navy during World War II. Later he was employed in the Press Metal Division of the Stanley Works until 1961, when he formed his own company, Pease Industrial Products, Inc. Marshall served as a deacon in his church and was a past president of

the Tuberculosis Association and the Family Service Association. We send condolences to the family.

Ed Bernard notes that he and I are both members of the Boston Chapter of SCORE (Service Corps of Retired Executives). Also in our chapter are Don Cunningham, '26, and Mark Shamban, '43. Are there any other class members volunteering their consulting services with this organization?

We look forward to hearing of all your activities.—**Richard E. Gladstone**, Secretary, 1208 Greendale Ave., Needham, MA 02192, (617) 449-2421

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Raymond G. O'Connell died last April; he was 68. Born in Port Chester, N.Y., he lived in Torrington and later for 33 years in Litchfield. At M.I.T. Ray, a born actor, was during all four years a key member of the Dramashop. He not only starred in many plays but helped build a loft for the crowded theater (before Kresge), painted sets, arranged fundraisers. For "Ten Nights in a Barroom" a miserable, peanut-throwing audience helped raise thousands toward Dean Fuller's goal of a new, independent theater.

Ray was also a member of Dorclan, an honorary dormitory society secretly hard at work to diminish the overwhelming influence of the fraternities in student affairs. He was in swimming, advanced R.O.T.C., Catholic Club and Nautical Association. A navy veteran, he joined the Torrington Co. in 1945, moving up through the ranks in sales and marketing positions. He was elected executive vice-president of Ingersoll Rand Co., the firm's parent company.

Ray was past president of the Torrington Chamber of Commerce, a director of Turner and Seymour Manufacturing, and a director of the Connecticut Public Expenditure Council. He served 12 years on the Litchfield Board of Education and was a member of the Litchfield Board of Wardens and Burgesses at the time of his death. In addition to his wife, Carolyn Healy O'Connell, he is survived by two sons and six grandchildren.—**Joseph E. Dietzgen**, Secretary, Box 790, Cotuit, MA 02635

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There is drought in the Midwest, but the news channels have poured forth a flood.

Bill Thurston, after a 45-year career, has retired from an active operating role at GenRad in Concord, Mass. Bill will retain his titles as chairman and director, and will represent GenRad to industry associations.

A report in the *Wall Street Journal* tells us that **Charles A. Duboc**, president of Penryn Corp., Kansas City, Mo., has been elected a director of Puritan-Bennett Corp. in Overland Park, Kans.

In Berlin, Conn., the Friends of the Berlin Free Library were addressed by **Victor Darnell** on the history of American bridge building and the Berlin Iron Bridge Co. Victor served for three years as a naval architect on navy repair and conversion projects, then went to work for the Berlin Steel Construction Co., where he was chief engineer from 1957 until his retirement in 1977. In addition to publishing articles and a book, he is an historical consultant to the Smithsonian Institution and has been an adviser to state highway bridge surveys in Texas, Vermont, and Massachusetts.

From Cincinnati, **Stewart Rose** wrote to announce his June 1987 retirement after 44 years with Procter & Gamble. Starting in ordnance manufacturing, Stewart progressed through research on soybean protein, technical brand management of Puffs tissues and Bounty towels, product and environmental safety for the Paper Division, and finally to regulatory affairs manager for the division. He now spends his summers bicycling and kayaking, and his winters doing volunteer work. He has gladly put aside the Federal Register to catch up on neglected reading and music.

I was saddened to receive a letter from **Dick Stern** reporting the death of his wife, Dorothy, in April. Despite his loss, Dick attended the 45th reunion, and, I hope, was strengthened and encouraged by the sympathetic greetings of his classmates.

The reunion itself was a tremendous success, thanks to the committee led by **Mort Spears**. Newport is an ideal location for such an affair—the weather was mostly favorable, the facilities were first-rate, and the activities program was a real winner. The only drawback was the restricted access to the city from the southwest (my arrival direction) because of extensive bridge repair work. (Yes, Mort, I know you couldn't think of everything.) From the arrival reception in the Hospitality Room at the Viking on Friday to the final checkout on Sunday, everything flowed smoothly. There was no trace of friction due to the Harvard class of '43 reunion moving in right behind us. We even gallantly assisted several of the Harvard chaps in locating the men's room.

The registration sheet indicated 72 class members and 59 spouses, friends, and guests in attendance. Most of the old regulars were there, but some I had not seen in many years: **Harry Ottinger**, **Jim Spitz**, **Ned Swanberg**. Present for his first reunion, ever, was **Bob Handler**, who found that Newport golf did not measure up to his customary variety in Florida. Representing faraway places with strange-sounding names, we had **Harish Amin**, who arrived from Bombay in a wheelchair, and **Y.K. Pei** from Beijing. **Cal Dunwoody** sent a note of regret that he could not attend because of a previous commitment to climb Mt. McKinley. **Dick Feingold**, a stalwart and tireless publicist for the reunion, told anyone who would listen how much better the world looks to him after his cataract operation. He likes it so well he may get another one.

In the interest of conserving space and not shooting the whole works at one time, I'll report more reunion news next month.—**Bob Rorschach**, Secretary, 2544 S. Norfolk, Tulsa, OK 74114

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By the time you read these notes, you should have received **Norm Sebell's** second letter with the corrected dates for Technology Day, June 9, 1989, and Bermuda departure, June 10, 1989. Please send back reservation cards, so plans can be completed early.

The Institute of Electrical and Electronic Engineers at their annual awards ceremony in Boston on May 9, 1988, awarded **James Ross MacDonald** the Edison Gold Medal (\$10,000 award) for seminal contributions to solid state science and technology and outstanding leadership as a research director. Jim is William R. Kenana, Jr. Professor of Physics at the University of North Carolina. . . . **John K. Breymann III** of Malden, Mass., died on April 19, 1988, of a heart attack while driving on the Massachusetts Turnpike. He had retired in 1986 as a vice-president of investments at the Bank of Boston. We extend our sympathy to his family. . . . **Albert P. Hildebrandt** sends word of his training for U.S. Masters Boardsailing championships to be held at Hilton Head, S.C., in September 1988.

Robert Bruce, professor emeritus of history at Boston University, recently won a Pulitzer Prize for his book, *The Launching of Modern American Science 1846 to 1876*. His article on Alexander Graham Bell will appear in the September issue of the *National Geographic* magazine. Bob graduated as an engineer and went on to become a historian, his first love.

The reunion committee met on June 27 at the home of Ruth and **Norm Sebell** with Anita and **Les Brindis**, Jane and **Lou Demarkles**, **Melissa Teixeira** and **Jim Baird**. Watch for reunion up-

dates and respond ASAP.—Co-secretaries: **Andy Corry**, 16 Brimstone Lane, Sudbury, MA 01776; **Lou Demarkles**, 53 Maugus Hill Rd., Wellesley, MA 02181

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Jim Brayton, **Pete Hickey**, and I have just returned from a great Maine cruise aboard **Katie** and **Jack Frieberger's** *Hinckley 48 yawl*; a week of clear days, cool nights, favorable winds and great great company. As a Maine coast cruiser, I can say that I have never seen seven such wonderful days back to back during the past 18 years.

Jack is fully retired from his assorted businesses and now divides his time between a Durango, Colo., retreat, the old home in Dallas, a new house just about completed at Man of War Cay in the Bahamas, and, of course, his 20-year-old *Hinckley*. Although we all look great in our early 60s, this vessel looks far better than any of us did at the age of 21!

Lou and **Pete Hickey**, who had just returned from a three-week visit to daughter Lisa and family in Hawaii, continue to enjoy their retirement in Topsfield, Mass., where they have lived the past 14 years. . . . **Ellen** and **Jim Brayton** had their usual two-week ski fling in Switzerland in January and are now safely ensconced in Little Compton, R.I.

My wife, **Fran**, ran into **Tom Hood** at Smith College in mid-May. Tom, who has long since been married to Marion Snee, Smith '48, is now into a third career teaching at Purdue University in West Lafayette, Ind. . . . **Dave Richards** of Newark, Ohio, has been retired for five years from Owens Corning Fiberglas after a 37-year career. After a start in the physics research lab in 1945, Bob spent his career in manufacturing and technical management positions in various construction project groups; the ultimate was his final position as research director at the Grenville, Ohio, Technical Center which employed 1,100 engineers and scientists. As Bob so aptly states, it was "a very interesting and rewarding career working with products ranging from house insulation to the insulation system for the Alaska pipeline and the roof structure for a 210-acre airport shelter in Saudi Arabia."

In mid-May, **Tom McNamara** wrote the following: "Retirement is great but hectic! I've stayed on a couple of national information committees and have lectured for the American Institute for Banking. These activities have kept Louise and me traveling—Lake Tahoe, Scottsdale, and an August 1987 trip aboard a Canadian Pacific Skyview from Toronto to Vancouver; now we are off on a cruise to Alaska!" Tom further reports that Louise is running down her teaching activities at Massachusetts Community College and that daughter Susan received a master's in education at Harvard last June.

In mid February, the Rhode Island Society of Professional Engineers named **Hedley Patterson**, of Woonsocket, Rhode Island's 1988 Engineer of the Year. . . . **L. Robert Gardner** of Cedar City, Utah, has continuously practiced architecture since 1948, and for many of these years, Bob has been the only architect between Provo, Utah, and Las Vegas.

Thirteen of us got together for dinner at the Colonade before Tech Night at the Pops on June 2—**Dee** and **Frank Gallagher**, **Ann** and **Bob Maglathlin**, **Nancy** and **Charlie Hart**, **Jan** and **Charlie Paterson**, **Carol** and **Jim Pickel**, and **Bill Meade**, as well as **Fran** and myself. **Bill**, **Stone** and **Webster**, retired bachelor, gardens in Marshfield, Mass. . . . **Jim Pickel**, a Gillette retiree, teaches math at Woodward School for Girls in Quincy. . . . **Charlie Paterson**, formerly a Texas Instrument stalwart, continues to be one of our better golfers. He further advises that he is hard at work on his 20-year-old home improvement project. The Maglathlins plan to sell their Norwell home and move into the summer home in Wareham once its winterization has been completed.

Yes, Bob continues some consulting. **Charlie Hart** is just beginning to enjoy his January 1 retirement from Raytheon.

Although **Frank Gallagher** claims to have passed the Cambridge-based family construction business to some of the kids, Dee advises that he still spends too much time at the shop. On the other hand, if one were to believe *New England Sailsboard Journal* of April 1988, Frank spends most of his time—and I mean year-round—wind surfing! What a wonderful article about our Frank who only sailed 12 times in February!

There is talk about having an off-year reunion trip to Ireland and the UK in the spring 1989. If you have any interest, please drop me a line—and you can bring us up to date on your activities at the same time!—**Clinton H. Springer**, Secretary, Box 288, New Castle, NH 03854

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Some how or other I keep gleaning new and sometimes surprising stories about our classmates out of the bio book. Meanwhile why not make yourselves a New Year's resolution to drop me some updates on your own status—just once a year would be fine. Otherwise, I can see the day coming when I'll start doing reruns on stuff I've already written—and wouldn't that be a drag.

Here's **Lewis "Jim" Mann**, a transplanted New Yorker and one of our "occasional" chemists now living/working in Fresno, Calif., where he is clinical chemist on the VA Hospital staff and a faculty member of the University of California Medical School teaching program these past 13 years. He started out "After Tech" (AT) by picking up a Ph.D. at Columbia in 1951 and did gigs with the pharmaceutical industry and army before landing a postdoctorate at Harvard Medical School in 1957. This led to a 14-year career in transplant immunology taking him, through NIH, to England and Denmark, and later to the University of Connecticut. Along the way, he married Marilyn, Wellesley '56, and raised three kids who are by now probably college grads. Marilyn, with Spanish teaching credentials, is an ESL teacher. Jim's hobbies include back packing in the Sierra, gardening, and volunteering in the Fresno High School Science Department. He remains "a poindy-[sic] headed East Coast liberal" and sees 70 as a good target retirement age (or, if Reagan persists, earlier via the R.I.F. process). Atta boy, Jim.

A short one from **Gil Mart**, originally a Portland, Ore., lad, who has lived in Orinda, Calif., the past eleven years since going to work with Bechtel in San Fran. Gil got his letter (I) in civil engineering and over the years has done time with companies in New York, Washington, and Saudi Arabia. He's also put two boys through M.I.T., but they ended up as medicine men, which ain't all that shabby. His wife, Margaret, is a retired teacher.

Another Californian transplanted from Rhode Island (Cranston) is **Bob O'Donnell** who lives, unwed, in "infamous Marin County," where he is retired after 39 years with Chevron. He is a serious photographer and likes to write; intends to get a computer to ease the longhand pain. Bob and his youngest daughter (one of five kids) took a trip to Yugoslavia in 1986, which is why he didn't make the reunion. Because of an "aborted stint in the military," he got out of sync with original classmates; instead he got thrown in with us V-12ers, etc., but made it through the rain with us, in spite of everything. Later, he tried rounding out his humanities by taking part in the Great Books Discussion program and served several terms as an officer and instructor for the Henry George School of Social Science. With all due respect to Tech, he would recommend the George School economic disciplines. Bob wishes us all the very best and welcomes us all to Danberry Lane in San Rafael (where we passed through on our California Odyssey in May).

Forgive me if this is a rerun, but it's still a fas-



A unique sign and a hearty goal marked the Class of 1948 table at the Technology Day luncheon early last June. Did they make it? Yes, and more, with

a total gift of \$6,609,882.

From left: Marty Billett, George Clifford, Priscilla Gray, Denny McNear, and Paul Gray.

inating story about **Sam Meerbaum**, who escaped with us in Course II and immediately grabbed an S.M. in September. Sam started out in New Jersey but shipped out in 1965 to California, where he got into space bioengineering. This led to an NIH grant which got him a Ph.D. from UCLA in the medical physiology field in 1970. He trained clinical doctors from all over the world and contributed to the development of experimental techniques in cardiology and physiology and traveled around the planet presenting new findings on concepts for cardiac imagery and treatment of coronary attacks. Sam's retired—sort of—but is developing a "consulting agenda." He lives in Woodland Hills, Calif., along with wife Nora, who bore him three "Valley Girls" all married and gainfully employed.

Have I mentioned **Jim Murphy**? A West Virginia lad who got through XVI with me and a zillion other V-12ers. Jim also ended up in L.A.—as a MacDougle program manager. But before then, he had picked up M.S. and Ph.D. aeronautical degrees at the University of Michigan, where he also worked in their research center. In 1951, he married Janet, a medical illustrator at University of Michigan and swept her off to the Brentwood environs (another nice address) in 1953. They have two kids—Jenanne, who works in software for Hughes, and Meade who works in advanced materials for Douglas Aircraft. Evidently, Jim still likes what he's doing and doesn't have any immediate retirement plan.

One more remarkable story concerns **Charles Neumann**, one of our special XIV meteor men who got sucked into the hurricane/typhoon game right off the bat, doing reconnaissance in the Western Pacific and Asia. After that stint, he got back to school for his M.S. and joined the A.F. Scientific Services only to be dragged back into active duty for another two years of hurricane hunting in the Atlantic/Caribbean. And before he could get out, he contracted polio which put him into a disability retirement. He and wife Elizabeth (since 1951) moved to Miami, where the weather allowed easier getting around with all the hardware he was hauling. Not to worry; the Wichita lineman went back on line again with the A.F., forecasting weather for SAC at Homestead AFB, following up by joining NOAA, forecasting for NASA's manned space programs. As chief of R&D at the National Hurricane Center in Coral Gables,

he has been around the globe, mostly in connection with training of foreign scientists in modern techniques of tropical cyclone prediction. The Neumanns have five children, all doing well. They have a condo up in Sugarbush, Vt., where they'd like to spend summers when he retires—sooner than later?—**Jim Ray**, Secretary, 2520 S. Ivanhoe Pl., Denver, CO 80222

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You have a new class secretary—**Robert E. McBride**, 1070 Pilgrim Parkway, Elm Grove, WI 53122, (414) 784-1971. His first column will appear in the November/December issue. Please send him news.—ed.

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Denny McNear presented our class's 40th reunion gift to M.I.T. during the luncheon program on Technology Day last June. We reached our goal of $(2\pi + \Delta)M$ with a total gift of \$6,609,882.05+. We were honored to have Priscilla and Paul Gray, '54, sit with our class. There were four tables of classmates at lunch, although the majority of the class skipped this event and are planning to join in the October reunion events.

Our gift included two endowed full professorships and six scholarship funds. Also included was a class of '48 reunion gift of \$460,000, student aid fund of \$234,000, and visiting professorship at \$62,000. Contributions were received from 620 classmates or 65 percent of our living classmates.

The following classmates attended Technology Day: **Bill Riordan**, **Ken Brock**, **Lou Kreek**, **Al Seville**, **Sam Hanna**, Rose, widow of **Leon Lafreniere** (with her new husband from the class of 1952), **Jim Pastoriza**, **Dick Harris**, **Stan Shein**, **Bill Maley**, **Jack Walch**, **Graham Sterling**, **Bob Turkington**, **Milt Slade**, **George Clifford**, **Harold Ottobriani**, **Sonny Monosson**, **Stan Abkowitz**, **Bob Sandman**, **Manny Kramer**, **Bob Ormiston**, **Harry Jones**, and yours truly.

Marion and **Bill Riordan** met in college. Marion was active in arranging dances on campus, which were attended by her friends working at the Radiation Labs. At present, Bill is "busy doing nothing" since his retirement from Bell Labs. Bill

Functional Art in the Eighties

By Michael Erard

Dudley Hartung, '52, is a thin, soft-spoken man with strong, hard hands, a Buddha of the decorative arts. He designs and makes unique furniture in a Somerville, Mass., studio under the name Hartung/Mason.

In the cavelike basement workshop of their converted soap factory, Dudley and his collaborator, Ellen Mason, are making a long settee with thin curved legs of cherry and scalloped wings of poplar on each end. As they talk, she does the legs with yellow paint, and he fits a jig together.

Hartung has been designing and making furniture for about 15 years. "Before that I was into more conventional M.I.T. endeavors," he says. After "squeaking by" with a degree in mechanical engineering, he eventually started his own business called Machine Control Co. He left after it was bought by a larger company. "I felt exploited. I feel that engineers in general tend to be exploited."

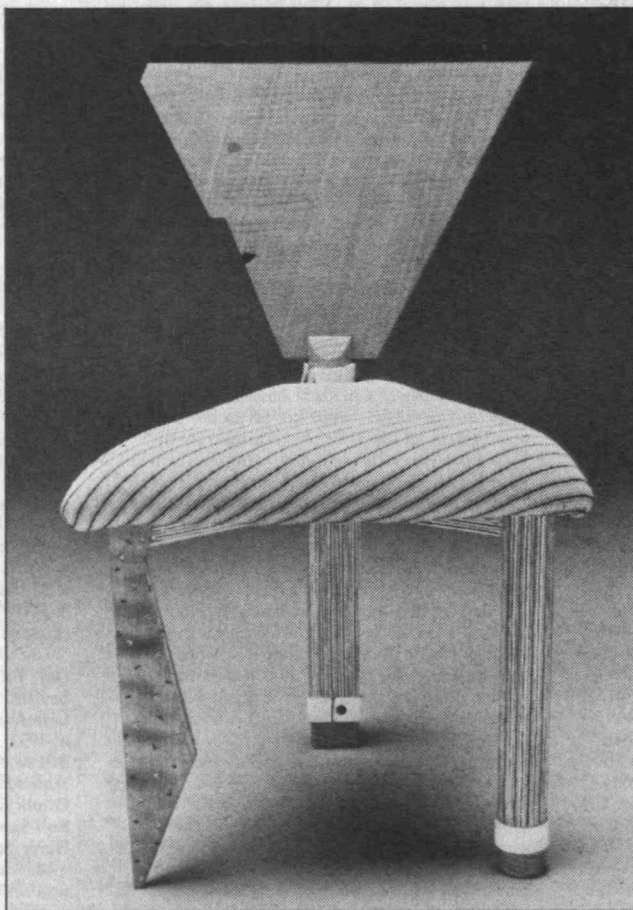
Working on guidance systems for the F-105 and Huey helicopters during the Viet-nam War added to this feeling. "The more I learned about the war, the more I got turned off by it, so I got out of doing military-type business," Hartung says. By removing himself from the military-industrial environment, he has removed himself from the pressure that drives both men and nations to succeed through aggression, he says.

Hartung spent his formative years on a farm and as a senior at M.I.T. had a full-time job as a pipe welder and a part-time position as a student technician in the Dynamic Analysis and Control Lab. Such a background of making things, especially with wood and metal, is only one of many paths to furniture making. Mason, previously a social scientist and a consultant, came to furniture making with a background in art history and theater set design.

Hartung and Mason's furniture has been called "functional but fun" by various publications, but Hartung prefers to use the word "interesting."



Above: Dudley Hartung, '52, works in his new Somerville, Mass., studio. Below: Functional but interesting—a Hartung/Mason face chair.



"Functional but interesting. Not always fun. Something that your eye appreciates. We often try to have some element of whimsy in it."

This whimsy is apparent in a series of chairs with a human head in profile for the back, rigid limbs for legs, and torso for the seat. The chairs are pleasantly sturdy and inviting, yet appear to be on the verge of animation whether occupied or not. Hartung and Mason's whimsy is pricey: about \$2,500 a chair. "The people who buy these things are not the people who live in the average Somerville three-family house," Hartung says. Although he could build such a chair in a week, he normally allows himself 2 to 4 weeks. He does not relish churning out chairs. The rush of mass production would spoil the satisfaction he derives from working with his hands. In any case, it is the limited number of these chairs that makes them unique.

"If the economy is good, I do adequately well," he admits. But one gets the feeling that the state of the economy is not the priority in his mind, even though he and Mason changed the name of their studio from Raccoon in order to "make it more appealing to contemporary art galleries."

"Our work sells best in New York, Philadelphia, and Washington art galleries. The local sales from our shop are a much smaller part," he says. "They [Bostonians] act like they appreciate art, but they don't spend a huge amount of money on art." And when they buy furniture, they tend to buy antiques and conventional craftsmanship instead of Hartung's funky furniture.

Hartung is a member of the Somerville Arts Council who believes in the value of art to the community. He thinks of his work as low-key political action "in the sense that I try to achieve something for the community that is good." □

MICHAEL ERARD is a junior at Williams College and an intern for Technology Review.

and Marion had six children over 20 years, and the youngest child is in high school. Bill is on the school board, which meets every two weeks. Their daughter has a fellowship in Spain, and one son is in Costa Rica with the Peace Corps.

Donald Marshall completed a three-and-one-half-year assignment as a volunteer-in-mission for the Presbyterian Church (USA) in Kansas City, Mo. He began the assignment after retiring from Unocal Corp. with 33 years of service. He has moved into a retirement facility on the beach in La Jolla, Calif. . . . **Ed Frohling's** company, Mountain States Mineral Enterprises, is developing a boron mine in the desert of California near Barstow. They expect to be the third substantial producer of boric acid in the world. . . . **Robert Deutsch** resigned from his position as chairman and CEO of General Physics Corp., Columbia, Md. . . . **Bill Weisz** has been appointed a director of Harris Bankcorp (a subsidiary of the Bank of Montreal). . . . **Richard Worrell** retired from Arco Chemical Corp. in 1987. He is enjoying golf, traveling, and volunteer work with church and Optimists Club. "Certainly beats working a regular schedule," he says.

At a recent meeting of the American Society of Naval Engineers, two classmates made presentations about certain technical aspects of naval history. They were **Capt. Joseph S. Stoutenburgh**, USNR (retired) and **Capt. Edmund B. Mahinske**, USNR (retired). . . . **Victor Ransom** retired in September. He spent 30 years with Bell Labs, and for the last five years he was with Bell Communications Research. He has started a new business, Systems for Special Needs, to provide computer-based systems and consulting services in the rehabilitation technology field.

Richard "Dick" Souza died at home in Lexington, Mass., after a brief illness. Dick founded Souza, True, and Partners, Inc., an engineering consulting firm in Watertown, in 1959. His partner, Ed True, was class of 1938. Dick served with the U.S. Army during World War II and was a Lexington town meeting member for 30 years. His family includes his wife, three children, two grandchildren, and his mother. On behalf of our classmates, I extend our sympathy to his family.

I am writing these notes in July, and the reunion committee has lots more work to do to organize and conduct our 40th reunion in October. I expect you will be reading these notes within a few days of the actual reunion October 7-9. It is too late to convince you to join us if you are not already planning to, but it is never too late to acknowledge the efforts of everyone involved. **Bob Sandman** is chairman; **Sonny Monosson** is making all the mailings and preparing the copy; **Graham Sterling** arranged a pre-reunion activity and has provided meeting space and support. **Milt Slade** is handling the money; **Harold Ottobri** has arranged an elegant dinner dance, among his several projects; **Malcolm Read** is doing the yearbook (for the second time). **Herb Lipson** and **Al Seville** are planning tours around Boston; **Stan Abkowitz**, **Ken Brock**, and **Dave Vigoda** are other members of the planning group. I arranged the speaker program and have asked **Bill Zimmerman**, **George Macomber**, and **Bill Thorbecke** to help with the introductions.—**Marty Billett**, Secretary, 16 Greenwood Ave., Barrington, RI 02806

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Up in Maine, there is a tiny neck of land pointing south into the Atlantic ten miles below Portland on which both the weary and the adventurous can find answers to their needs; for here lies the town (hamlet?) of Proust's Neck, as restful and recuperative a place as ever was. Winslow Homer lived there (1883-1910) along with other refugees from the cares of urban life. His paintings *Cannon Rock*, *Fog Warning*, *Herring Net*, and *Driftwood* reflect accurately the scenes abounding there today.

Five years before Homer arrived, a gracious

hostelry known as the Black Point Inn was built and, under a series of gentleman-owners, survives in understated comfort and elegance to this day. And that, friends, thanks to the diligence of class president, **Frank Hulsmit**, who lives nearby, is where we'll be for the three-day off-campus part of our 40th reunion next June 9-11. Not a single beach bum or pot snorter is to be found in these environs, and even the likes of Elton John have been turned away, which is not to say that the place is stuffy. No indeed. Quiet, comfortable, and luxurious are better words for describing the place. But if you are feeling active, there are golf links, tennis courts, heated pools outside and in, hiking, biking, birding, fishing, two white sand beaches, plus a 41-foot ketch and 27-foot power cruiser to take you out on Casco Bay. And finally, lest the fear of starvation while in this isolated part of the country gives you pause, the management has provided thoughtfully for appetites ranging from picky to extreme. And while we are on the subject of food, the class banquet will be held on Saturday night.

A news release, dated April 26, 1988, from the National Academy of Sciences states that **James P. Gordon** has been elected to membership in that organization. Further, the release tells us that "election to membership in the Academy is considered one of the highest honors that can be accorded an American scientist or engineer." The Academy was established in 1861 by a congressional act of incorporation, signed by Abraham Lincoln, that calls upon the Academy to act as an official advisor to the federal government, upon request, in any matter of science or technology. We in the class can feel honored that Jim is one of us.

Thomas L. Hilton writes that he is still a senior research scientist at Educational Testing Service in Princeton, N.J. On August 3, 1988, he gave an invited address on the "Research Needs of Guidance" at the International Congress on Educational and Vocational Guidance in Stockholm, Sweden.

According to the March 10, 1988 edition of the *Toronto, Canada Globe and Mail*, **Edward S. Rogers**, Ph.D., curator of the Royal Ontario Museum in Toronto, died March 8, 1988, at the age of 64. He was due to retire in June. An obituary in the March 16 issue of the *Burlington (Canada) Post* provides biographical details. Rogers was head of the Department of Ethnology at the museum from 1963 to 1986. He was a parttime professor of anthropology at McMaster University from 1970 to 1987 and also had been a professor at the University of Toronto from 1964 to 1969. Professionally, he was an expert on the Cree and Ojibwa cultures. This knowledge was called upon both by Canada's native people and government bodies. He acted as an unofficial mediator between the two sides on occasion and had been called upon by the native people as an expert witness in connection with their land claims. Rogers is survived by his wife Mary Black-Rogers of Burlington, a daughter Corinne Rogers-Whelan of Richmond, B.C., and a granddaughter, Liam. The class extends its deep sympathy to the family.—**Fletcher Eaton**, Secretary, 42 Perry Dr., Needham, MA 02192, (617) 449-1614

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Our 40th reunion gift committee, directed by co-chairmen **Bill Maini** and **Marvin Grossman**, is continuing its work in endeavouring to determine a meaningful use and purpose for our gift to the Institute that will serve as a rallying point for our fund raising effort. Meetings have been held with M.I.T. President Paul Gray and many of the other Institute notables to solicit their ideas and suggestions. The concept of providing funds to promote and motivate teaching excellence is looking increasingly attractive. We invite you to send us your thoughts and suggestions.

The 1988 winner of the Riest-Davis Institute of Food Technologists Food Packaging award is

Aaron L. Brody. The honor was awarded for contributions that include the development of controlled atmosphere processing and packaging, the recently introduced crosscheck aseptic packaging system, and plastic film multiple packaging. He is the author of several books and is a columnist for several journals including *Cereal Foods World* and *Food & Drug Packaging*. Brody is a major consultant in international food packaging and in strategic planning and implementation. He and his wife, Carolyn, live in Devon, Pa.

Sadly, we received news of the passing of **William A. Krampert**. He was living in Green Valley, Ariz. We extend our condolences to his widow and to his daughter, Pat Aldrich.—**Martin N. Greenfield**, Secretary, 25 Darrell Dr., Randolph, MA 02368

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Oliver "Ells" Hall, of McLean, Va., died March 3, 1988. A member of Kappa Sigma and a graduate of course I at M.I.T., he made his career in naval avionics systems. He is survived by his wife Lorraine.

Mike Lubin is serving as vice-president for events of the M.I.T. Club of Northern California. He has organized for August a motorcycle trip through some of the San Francisco Bay area's back roads. The tour is a 150-mile loop running from San Leandro to Mount Hamilton to Livermore and return.—**Richard F. Lacey**, Secretary, 2340 Cowper St., Palo Alto, CA 94301

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This is the first set of notes prepared after our 35th class reunion and my last as class secretary, so I'll say so long for a while. **Marty Wohl** is our new class president, replacing **Fred Brecher** whose efforts over the past ten years were re-soundingly applauded by all those present at both the banquet/dance at which the election took place and at the dinner the following night. **Gil Gardner** is resuming his role as class secretary after a five-year hiatus; so after this, he'll be preparing our class notes. The reunion was, indeed, a lot of fun, sharing memories and catching up on the events in the lives of our classmates. I believe over 60 of us attended at least one and often several of the class functions, and for a few this was their first reunion since graduation.

Let me briefly catch you up with the information received on some of our classmates. Professor **Elliott H. Lieb** recently received the George David Birkhoff Prize for outstanding contributions to applied mathematics in several areas of physics. The prize is awarded jointly every five years by the American Mathematical Society and the Society for Industrial and Applied Mathematics.

... **Ernest J. Allard, Jr.** informs us that he retired at the end of last year from NOP, Inc., a unit of Allied Signal, after 34 years, his last position being district manager (western district) for licensing and technology marketing. . . . **Marvin M. Turkanis** writes that he's been at Neutron Products for 21 years and has helped the company capture a large share of the medical radiotherapy market using a telemarketing system he developed and directed. He is currently a director of the Maryland International Trade Association.

I also received a short note from **Robert M. (Bob) Colton**. He left the National Science Foundation in late 1987 after 32 years with the government to establish his own consulting firm, Robert M. Colton Associates. The firm is involved in technology transfer. He has set up cooperative programs between universities and industry, and he identifies emerging technologies having commercial potential for investment purposes. His wife, Janis, has been in private practice for the past three years as a clinical social worker, and his eldest son, Jonathan, '81, earned his B.S., M.S., and Ph.D. in mechanical engineering from

M.I.T. He is now an assistant professor at Georgia Tech. Last August Jonathan married another M.I.T. graduate in M.E., Rachael Graber, '87. Another son, Larry, received a B.S. in chemical engineering from Tufts and went on for a law degree, while youngest son, Michael, received his B.A. in criminology.

Also recently announced is the election of Professor **Joseph J. Kohn**, who, like **Elliott Lieb**, teaches mathematics at Princeton University, to the National Academy of Sciences.

It is with sorrow that I must report the death of **Robert J. Browne**. Our sincerest sympathy to his family.—**Wolf Haberman**, Secretary (outgoing), 41 Crestwood Dr., Framingham, MA 01701

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Don Goldberg and **Bill Zoino** founded their engineering firm, Goldberg-Zoino & Associates, in 1964. It has grown into a multimillion-dollar company over the years, and recently has been attracting media attention, although its work is seldom visible. The firm specializes in subsurface groundwater and foundation engineering, designing and evaluating foundations for buildings, dams, highways, railroads, and other developments. It also specializes in the cleanup of hazardous-waste dump sites. In fact, the company won an award for overseeing the cleanup of a waste site in Nashua, N.H. Company headquarters are in Newton Upper Falls, Mass. Don lives in Waban and Bill lives in Brockton.

Paul Gray has been named a director of the Shawmut National Corp. in Boston. Paul and Priscilla will host a visit to the President's House as part of our 35th reunion next June. It is time to put the reunion on your calendar. It will run from June 8 through June 11, with a possible extension into the next week. **Bob Warshawer** and his committee are meeting to complete the planning for the event (you may have already heard from Bob by the time you read these notes).

Reunion time is also the time when we try to locate lost classmates. We have no verifiable addresses for the following: **Mariano Avelo**, **John S. Avery**, **Sydney Balsbaugh**, **James R. Bannon**, **Francis Bartis**, **Carlos A. Basalo**, **Robert M. Beckett**, **Yohay Ben Nun**, **Mrunal N. Bhagat**, **Antonio Boccandroperez**, **Irving R. Bogue**, **David P. Boom**, **Richard A. Brass**, **Mrs. Carolyn E. Breed**, **Henry P. Briggs**, **Donald P. Carroll**, **S. Robert Caso**, **Sergio Chavez Jofre**, **Jeremy S. Connolly**, **Henry S. Davidson**, **James H. Davidson**, **Edward L. Davis**, **Phillipe G. Dennerly**, **Vaughn Dobalian**, **William C. Doonan, Jr.**, **Robert R. Dow**, **John C. Elac**, **Marcelo R. Fernandez Font**, **Rafael Fessel**, **John C. Ffield**, **John J. Fitzpatrick**, **John R. Giancola**, **Anthony R. Giannangeli**, **Robert W. Gilliland**, **Eugene A. Graham, Jr.**, **Lawrence M. Hagen**, **Jack F. Hagestad**, **Donald F. Hastings**, **Fred Herzfeld**, **Theodore Higier**, **Wells Hively, II**, **Mark Jablonko**, **Gerald D. Jackson**, **Philip N. James**, **Anthony C. Jannicky**, **Joseph J. Janovsky**, **Herbert Kleiman**, **Alexander Klimshuk**, **Nicholas P. Koines**, **Daniel Kokiell**, **Ephraim Komissaroff**, **Francesco B. Latini**, **Robert W. Lauffer**, **Harry M. Leese, Jr.**, **Jack W. Livingston**, **Alexander A. Lukshin**, and **Walter Marvin, Jr.** That is only half the list; we will complete it next issue. If you know the whereabouts of any of these folks, please let us know or send a note to the M.I.T. Association of Alumni and Alumnae.—**Edwin G. Eigel, Jr.**, Secretary, 33 Peppercorn Ln., Fairfield, CT 06430; **Joseph P. Blake, Jr.**, Assistant Secretary, 74 Lawrence Rd., Medford, MA 02155

55

The **Greenes** and the **Ehrlicks** represented the Class of '55 at Tech Night at the Pops once again this year. It is hard to believe that 33 years have passed since our undergraduate days at the Toot! We observed that the 50th reunion group appears

to be getting younger. The number of 50th attendees is also increasing each year—those red jackets keep moving further back in the hall. We assume they are living longer (which is good news) and that a larger percentage are coming (which is also good news). We should start a pool on the numbers for 55's 50th!

The Wall Street Journal reports that **S. Leslie Misrock**, senior partner, **Pennie and Edmonds**, New York, N.Y., has resigned as director, **Praxis Biologics, Inc.**, Rochester, N.Y. . . . **Joseph Carleton's** note from Palo Alto, Calif., tells us that his work in accident investigation/forensic engineering continues, with more time spent in depositions. There is no end to the number of things that can go wrong with cars, machinery, and people. Wife Ruth and he are active in **Neighbors Abroad**, which operates sister cities' programs with Palo, Philippines; Oaxaca, Mexico; Enschede, the Netherlands; and Linköping, Sweden. They camped in Glacier Park and visited friends in Vancouver the last two summers and spent several enjoyable days at Expo in 1986. He reports that the local M.I.T. Alumni Club has excellent programs, and he considers himself very fortunate in that regard.

Marc Gross has a new longer letterhead. His New York firm of **Stiefel, Gross, and Kurland** recently combined with the St. Louis-based firm of **Bryan, Cave, McPheeters, and McRoberts**. **Stiefel, Gross** specialties are patent, trademark, unfair competition, and copyright law, and their practice areas cover the full range of intellectual property matters. Marc has an undergraduate degree in chemical engineering from M.I.T. and a law degree from George Washington University. He was a law clerk for a judge at the U.S. Court of Customs and Patent Appeals and has lectured at intellectual property programs. The New York office of the expanded **Bryan, Cave** firm at 350 Park Avenue now includes seven partners and eight associates.

A Boston high school student helped save **Fred Lupton's** life last April. Fred suffered cardiac arrest in front of the North Terminal (Washington, D.C.) National Airport. A young woman from Boston immediately began cardio-pulmonary resuscitation (CPR) and worked with him until the paramedics arrived. She later told one of the paramedics that all Boston high schools require CPR training before graduation and that she had completed her certification only three days before. Because this young Bostonian was at the scene and knew CPR, Fred escaped the brain damage that could have occurred in the first four critical minutes after his collapse. Fred, who has recovered nicely, has not yet found out the name of the young lady but reports that he is very grateful to her and the Boston school CPR program.

Keep the news coming.—**Robert P. Green**, Co-secretary, 37 Great Rock Rd., Sherborn, MA 01770; **DuWayne J. Peterson, Jr.**, Co-secretary, 201 E. 79th St., New York, NY 10021

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Frank Amoroso, senior staff engineer in the Ground Systems Group of **Hughes Aircraft Co.**, has recently been an instructor at UCLA and George Washington University for an extension course on digital and analog modulation. Frank has extensive experience in the analysis of tactical spread-spectrum data, concentrating much of his work on the effects of waveforms and modulation on band-width and communication efficiency. Prior to joining **Hughes**, he worked at the **MITRE Corp.**, **RCA David Sarnoff Research Labs.**, and **M.I.T.'s Instrumentation Laboratory**. He has authored 15 papers for *IEEE Transactions* and other archival-quality journals, plus eight major IEEE conference papers; holds a U.S. patent (Multimode Noise Generator Using Digital FM); is a registered engineer in California; and has served as a session organizer and chairman for the IEEE Conference on Military Communications. Frank also held an instructorship at Purdue

and a fellowship at University of Turin, Italy. He now resides at Santa Ana, Calif.

Richard Jacobs, senior vice-president and director of A. T. Kearny, is the author of "Managing Business Today and Tomorrow," a chapter in *Productivity and Quality Through Science and Technology* edited by **Shetty and Buehler**, Quorum Books. Dick has expressed interest in a class Midwest mailing list for personal mailing to "drum up" more interest for 1991. His firm is located in Chicago. . . . **Thelma (Mrs. Bob) Pollard's** oldest daughter, Susan, graduated from Bates, is married, and living in Maine. Their youngest, Debbie, is a senior at Bates. Thelma spent part of the summer working on Bob's scholarship fund. . . .

Andrew J. Viterbi, chief technical officer of **Qualcomm, Inc.**, San Diego, was a scheduled speaker in the Colloquium Series of the Laboratory for Information and Decision Systems (LIDS). His talk, "Coded ALOHA: A Simple Approach to Increasing Multiple Access Throughput," was held at M.I.T. this past May. Dr. Viterbi is a founder of both **Qualcomm** and the **Linkabit Corp.** He is also professor of electrical and computer engineering at the University of California, San Diego. Andrew is best known for the "Viterbi Algorithm" and for his research in communication and information theory.—Co-secretaries: **George H. Brattin**, 39 Bartlett St., Andover, MA 01810, (508) 470-2730; **Irwin C. Gross**, Sweet's McGraw-Hill, 1221 Ave. of the Americas, New York, NY 10020, (212) 512-3181

60

This has been a slow news month for 1960, but I have appreciated your enthusiastic support of your column during the past year. So, too, have I appreciated your generosity to the Alumni Fund, making my class agent's hat an easy one to wear. Our class project to endow faculty efforts directed toward innovations in education is doing well, but we need your continuing support. To those of you I haven't heard from, please drop me a line or two. . . . and maybe also a check to the Alumni Fund.

I recently received a press release announcing the advancement of **George Pillorge** to the College of Fellows of the American Institute of Architects. George is a principal and vice-chairman of the board of **RTKL Associates** in Baltimore, Md., where he, his wife, Debbie, and three children reside. George has been with **RTKL** since 1964, during which he has been recognized many times for his designs of major projects such as Baltimore's Inner Harbor Center, the Town Center for Boca Raton, Fla., and the Reston (Va.) Town Center.

I am also happy to report that **Terry Welch** is recovering well from cancer surgery and is back working fulltime on software engineering tools at **International Software Systems** in Austin, Tex.—**Frank A. Tapparo**, Secretary, 15 S. Montague St., Arlington, VA 22204

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I am sad to report the death of **Alan Buchsbaum** a year ago last April. A course IV graduate, he lived in New York City.

A nice note from **Ed Sonn** came in the mail last June. He now works at Digital and is responsible for the retail segment (whatever that is). Ed reports that his son Paul just finished at Dartmouth and his daughter Kathryn, who is normally at Smith, is spending her junior year at Dartmouth. Ed notes that Digital is awash with '61ers: **Dave Gross**, **Tom Hastings**, **Mike Leis**, **Earl VanHorn** and now, Ed. He sent me the internal Digital newspaper, and there was a picture of Tom, Dave, and Mike, all being honored for coming up with five (or more) patents over the year. Tom, who is in "Low End Systems" (I wish I knew what that was) has six patents to his name. Dave (Semiconductor Organization) and

Mike (Storage Systems) only had five.

A lot of movement in the higher echelons of industry to report this month. A handsome picture of **Ed Turetzky** came in the mail from Uniroyal-Goodyear with a press release announcing his elevation to the presidency of their Textile Operations in Winstboro, S.C. It's both a career and a physical move. Ed and family will have to move from Hudson, Ohio, down to Columbia, S.C. . . . Also moving up the ladder is **Bruce Tarter**. He is now associate director for physics at Lawrence Livermore Lab. That means running an \$80 million program with 350 physicists, engineers, and general hangers-on in ten divisions. Sounds like ulcer time! Bruce is an expert in the interactions of X-rays and matter (SDI?) along with theoretical work in astrophysics. . . . **Angelo Lamola** has moved from Polaroid to the Shipley Co. in Newton, Mass., where he is vice-president of R&D.

John Sununu, our class governor, is quitting. "A firm decision, an irrevocable decision," he says. His wife, Nancy, will be glad to be leaving the public eye and returning to home life. But, if the papers are correct, there may be a spot for John in a Bush administration (if there is one).—**Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, MA 02167

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I received a nice letter from **Vito A. Caravito** and am passing his thoughts along to you as this month's column. Vito writes: "Part of the incentive [for writing] is the fact that I was at M.I.T. last week. I go about two or three times a year for alumni-related meetings, but this time it was business. We had a session with Professor Donovan at the Cambridge Institute, and I worked in a meeting with the Mechanical Engineering Department. I'm working at Goodyear Tire (have since graduation), and we've decided to offer a cash award through Course II for papers. It's a part of our efforts to attract M.I.T. grads (obviously)."

"For a change, the Cambridge weather cooperated, so I took a couple of hours aside for sight-seeing around the campus. Usually it's 'business suit' and in and out of a meeting room, so it was fun to go 'jeans and sneakers' and try to look like I belonged there. It's really become quite a healthy jog across the campus. The Coop down at Kendall Square to the dorms up by the Regency is a stretch for this kid. I used to make the daily trek to the crew boathouse from East Campus when I was a student, but I swear it was a shorter distance then. It must have something to do with the expanding universe theory."

"Other than the interstellar distances involved, it still seems like a good place to be and to learn. I'm basing a lot of that opinion on the fact that the students there seem happy. Given, there's seriousness, but there also seems to be freedom and fun. My youngest son was there about two years ago. He took a tour of the campus on his own, and he said he couldn't really tell who the students were. Everyone seemed like they belonged, and they all seemed like people you'd see in any downtown city environment. He was impressed, and impressing a 17-year-old today is quite an accomplishment."

"I wish we could get more of the alumni back to visit. It's still no ivy-walled showplace, and I'm sure that people our age might have a little difficulty appreciating the gay liberation posters on the walls, but anyone who deals in today's business and/or technical environment would have to appreciate that M.I.T. must be contemporary. The graduate is going to play in today's world, so that graduate must train on today's playing field. But be it relative to the past or present, I think the grads can be proud of the teaching and pioneering work done at M.I.T. which brought us to today, and is preparing us for tomorrow."

"Enough commercial. . . on to a few personal items. I've worked in quite a few areas at Good-

Setting the Stage for a Breakthrough

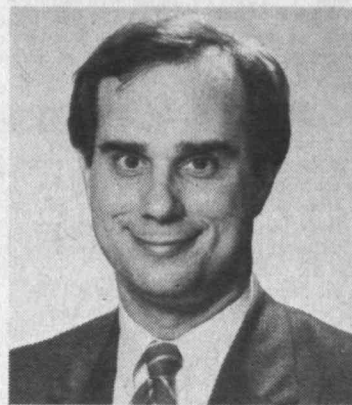
If you want a breakthrough in your company, look for a "breakdown"—a moment of tension when there is an opportunity for you to take "extraordinary" action, says **Allan L. Scherr**, '62, vice-president of development and integration for IBM's Application Systems Division, Milford, Conn. Scherr has been working for the last several years on the issue of producing extraordinary results with technical teams.

If everything is going according to plan, explains Scherr, achieving goals depends simply on executing plans. But in a time of breakdown, "planned business-as-usual approaches are seen to be inadequate. People focus their attention and see things differently," explains Scherr.

It's this shift of perspective that often reveals "the opportunity for previously unconsidered action"—that is, a breakthrough, says Scherr.

For example, consider the problem a company confronts when the design of a new product, a cooperative project of two groups, reaches an impasse; the two groups disagree fundamentally about how to proceed. The project manager finds the two teams more concerned with defending turf than solving the problem.

The traditional solution to resolve the "breakdown" is to pick one group's approach over the other's. But the team is damaged and the opportunity for a breakthrough is lost. Instead, the manager takes an unprecedented step. The combination of having each participant clarify their commitment to the combined team's success and the manager's insistence that a joint solution be found creates the tension



Allan L. Scherr, '62

for a breakthrough. Now all participants confront a breakdown situation. Two weeks later, success—a solution, a technical breakthrough.

Sometimes it takes patience; the stalemate of a breakdown lasts longer than the participants think it should, and pressure builds for a different option—a change in requirements or commitment. Scherr admits that as time goes on the risks go up. But "breakthrough results cannot be achieved by playing it safe," he writes. "Unprecedented, extraordinary results will never be created simply by executing the predictable formulas from the past."

Why do small, new companies score more breakthroughs than big, older ones? Because, says Scherr, when a small company comes up against a breakdown, its options are fewer. "The strength of a small company in the face of a breakdown is its lack of flexibility," he writes. Its only chance is to find the breakthrough. □

year but have spent the last four or five years in a group called Tire-Vehicle Engineering Technology (TVET). I'm a chief engineer with responsibility for implementation of CAE in the tire/vehicle system engineering process. So, the work gets heavily into cars and computers as well as tires. I get to deal a good bit with M.I.T. personally, as I'm an Educational Counselor and have been on the Alumni Fund and Alumni Association boards, but work also provides a few interfaces.

"We're a part of the Industrial Liaison program and also have a special 'target team' to promote hiring and awareness of Goodyear at M.I.T. I'm connected with both of these. The efforts get a bit time consuming, but Jo (Joann) and I have the family pretty much grown and on their own, so maybe it's all therapeutic, filling a middle age void for me. I won't bore you with the many titles and honors I've received or with the books and papers I've authored—chiefly because there aren't any of significance, just what you'd normally expect for a 25-year career. If I can be of serv-

ice to you, or to others, give me a call."

Vito can be reached at 2912 Eldon Dr., Uniontown, OH 44685. His business address is: The Goodyear Tire & Rubber Co., Technical Center D/460G, Akron, OH 44316, (216) 796-8613. Vito's letter appears with his permission. If any other classmates would like to write, I promise to clear any extensive use of your prose or poetry before publication. This is not to say that all written input will be published, but just like the *New York Times*, "all the news that fits we'll print," or something like that.

So keep those letters coming.—**Hank McCarl**, Secretary, P.O. Box 352, Birmingham, AL 35201-0352

63

What a wonderful celebration—our 25th reunion, held June 2-5. About 140 of us were able to attend—plus spouses, friends, and children.

Mostly we mingled together to report to each other what has happened so far on our diverse travels on the river of life. We joined for dinners, concerts, a group photo, and other events.

Maybe what we shared most was a sense of adventure and optimism. Not all of us are honored scholars or captains of industry. Indeed, most of us are obscure in the mass of humanity, even within the class of '63. Yet we have almost all found at least small pools of endeavor in which we could immerse ourselves and accomplish something. We did this despite being part of a transitional epoch. We are too old to be baby boomers and too young to be linked to the values of the Depression and earlier. So we are somewhat unanchored, but we try to find what is best.

Now to some hard news. First, our class has set a record of which we can be proud. We gave M.I.T. more than \$3 million, which is the largest class 25th reunion gift ever. We have to thank classmate **Dave Johnson** for his gathering and organizing efforts. Also to be praised is our outgoing class President **Jack Lynch**, who piloted the planning of the reunion.

Among the features were Tech Night at Pops and a gala Friday-night buffet at the Kennedy library. On Saturday morning informal talks were given by Nobel laureate David Baltimore on the facts about AIDS, Amar Bose, '51, on the facts behind the 'new' 6.01 course that many of us in Course VI shared 28 years ago (the profs stayed about a week ahead of us and did worse on the exams than we did), and Michael Morton on the facts of computerization—that it does not improve productivity unless corporate organization changes. The Saturday-night informal buffet included songs of the sixties from a live band, and a review of some of the best hacks in Tech's long history. (We may have a reprise of that, with audio-visuals, at the next reunion, so mark your calendars now.)

We also elected class officers for the next five years. One of the winning candidates noted that the train left the station some 30 minutes before the election, but we still got a good crew. They are: President **Pete van Aken**, Vice-President **Ken Anderson**, Treasurer **Steve Bernstein**, Class Agent **Marty Schrage** (the person who duns you from time to time for the 'tute), and I am afraid you will have to put up with me again as secretary.

Now some notes not related to the reunion. Inspired by his attendance at the reunion, **Roy Kormack** wrote to say that in January he left Bose Corp. to get back into the small-company environment. He is now with Bytex in Southborough, Mass., as CAD/CAE manager. Roy and his wife, Lauren, a psychotherapist, live in Natick with his son, Andy, who is 17 and active in soccer and basketball.

Patricia Sherman has been promoted to senior vice-president of Matarazzo Design, a national land planning, architecture, and landscape architecture firm in Concord, N.H., and Boston. Pat has increased the architecture department from one to 10 people in just five years, and directed Straw Hill, a condo project in Manchester, N.H., that won the 1987 Award of Excellence from the Urban Land Institute. . . . **Dave Juncker** is changing careers, from technical management consulting to his "first love-policy development and strategic planning for the United Nations Association." He lives in Minneapolis. . . . Finally, both **M. K. Maul** and his wife, June (Paradise), '67, still work in management at AT&T. They "live in rural New Jersey on six acres with four dogs, six arabian horses, and an unknown number of cats."

Regard for now. Please remember to write or phone with your news.—**Phil Marcus**, Secretary, 3410 Orange Grove Ct., Ellicott City, MD 21043, (301) 750-0184

64

Happy Autumn! Twenty-five years ago, most of us were busy "shopping" for senior thesis topics

as our undergraduate careers at the Institute were starting to wind down. The process of job interviewing and/or taking GREs was also underway. Busy times!

Twenty-five years later, we are all still busy, but in different ways. **Ken Ekstrand** writes from Winston-Salem, N.C., that he has been elected president of the Southeastern Chapter of the American Association of Physicians in Medicine. The chapter encompasses the area from North Carolina to Florida. . . . Just down the road in Pendleton, S.C., is **Henry Rack**, who is now a professor of mechanical engineering and metallurgy at Clemson University. He is specializing in advanced materials and composites.

Happy news from **Len Theran**, who was recently married to the former Alyson Stevens Erickson. Len was given away by his daughters Sally and Rachel; **Steve Glassman** was the best man. Also attending were **Bruce Strauss** and **Frank Berkman**. Congratulations!

Michael Hale writes from Beaverton, Ore., that he is working with other alumni in the Portland area to get a local M.I.T. club going again. Any classmates who are interested can reach Michael during the day at (503) 222-7895. . . . Down the coast in Los Altos, Calif., is **Ralph Bestock**, who is "still playing with technology" at Atalla Corp., which recently merged with Tandem Computers. Ralph and his wife, Donna, celebrated their 22nd wedding anniversary in March. Bravo! Their children, Laurel (11) and Andrew (7), are more interested in Stanford (warm climate) than M.I.T.

From **Ron Gilman** comes news that he was elected vice-president of the Tennessee Bar Association and is now in line for automatic elevation to be president in 1990. He is a partner in the Memphis firm of Farris, Hancock, Gilman, Branan, and Hellen. Ron is still regional chairman of the M.I.T. Educational Council and continues to pursue magic as an avocation. He has performed volunteer shows for the local children's hospital and the Memphis Cub Scout city camp. Daughter Laura is a junior at Boston University, and daughter Sherry is a senior in high school.

Louise and I spent an enjoyable weekend at Phillips Academy in Andover celebrating the graduation of our daughter Jennifer. The New England weather was about as nice as can be — maybe we'll be equally lucky at our 25th reunion next June.

Please send your news; the envelope is getting close to empty.—**Joe Kasper**, Secretary, 3502 Idaho Ave., NW, Washington, DC 20016

65

The column gets thinner each month; perhaps the summer doldrums as I assemble this one. . . .

Jim Cheng has been appointed president and CEO of Network Dynamics, Inc., a Cambridge-based software company that offers "rapid modeling" software for manufacturing system design and evaluation. . . . **Peter Heinemann** writes from Needham, Mass., that he's working as a consultant through Humanics, a company that he founded, specializing in graphics and user interface. . . . A note from **Chuck Hurd** that he's back to Holland again doing computer database consulting for GE. Chuck says that last time he went there he came home with a Dutch wife and two kids, and "who knows what this time will bring."

Col. Charles Seniawski writes that he's still stationed at F. E. Warren A.F.B., Wyo., but is now the commander of Detachment 60, Ogden Air Logistics Center. He says that Detachment 60 is responsible for refurbishing the 25-year-old Minuteman missile facilities and installing Peacekeeper (MX) missiles and components. He also just took up skiing and loves it. . . . **Mark Eisner** is now vice-chairman of Softbridge Microsystems Corp. in Cambridge.

Not a big column this time. Maybe more notes when fall reaches New England. I'm still interested in volunteers who might want to take over the column at or before the next reunion.—**Steve Lip-**

ner, Secretary, 6 Midland Rd., Wellesley, MA 02181

66

Terry Cronberg became a father last September—his daughter is named Ingrid. He is also managing a small sailcloth company, Challenge Sailcloth, in Rockville, Conn. . . . **Forrest Stoddard** is working as adjunct research professor at West Texas University half-time. The rest of the time he is a consultant to the wind turbine R&D community and the U.S. Department of Energy. . . . **R. D. Camerini-Otero** has been married to his wife, Carol, for 19 years. They have a son David (8) and a daughter Sara (3). He is still at the NIH in Bethesda, Md., and is chief of the genetics and biochemistry branch, doing research on molecular biology.

Mitsubishi has established a finance professorship with a \$1.5 million gift to the Sloan School, and **Robert Pindyck** has been named as the first holder of this chair. Bob is a widely known authority on the economics of energy and natural resources, and has been at the Sloan School since he received his Ph.D. in 1971. . . . The Sloan School has also promoted **Stuart Madnick** to professor of management science.—**Jeff Kenton**, Secretary, 7 Hill Top Rd., Weston, MA 02193

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Michael Rosenblum is now the proud father of two sons, Morgan (3) and Owen (1). Michael also reports that Kathleen and **Larry Gottlieb** announced the birth of Luke Victor in January. . . . **Bill Lange** has been promoted to vice-president of airline planning for Pan Am World Airways, Inc., of New York. . . . **Alan Hirsch** is a senior planning analyst with Amoco Corp. in its Information Services Department. He is also a member of the ANSI Committee on data base languages. Alan has traveled widely in recent years—China, Peru, Great Britain, and Australia. He has also performed as a singer with the Chicago Symphony Chorus for the past 20 seasons.

Michael Scott's Los Angeles law firm, Scott & Roxborough, specializes in domestic and international computer law, intellectual property law, and business litigation. . . . **Yupo Chap** is now professor and deputy head of the Operational Sciences Department, School of Engineering at the Air Force Institute of Technology. AFIT is the accredited graduate college of the Air University System. It ranks among the top 12 engineering schools in the nation in terms of degrees granted at the master's and doctoral levels.

David Griffel is planning to be a candidate for the U.S. Senate seat held by Ted Kennedy and intends to bring a new set of issues to the voters. At the time these notes were written, he was collecting the 30,000 signatures needed by August 2 to place his name on the ballot as an independent. David is concerned about the federal government's top heavy bureaucracy and the effects that massive and inefficient administrative operations have on the delivery of services.—**Jim Swanson**, Secretary, 878 Hoffman Terr., Los Altos, CA 94022

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Our glorious 20th reunion is now history. The weather held up very well, and it only rained at a noncritical time. We should thank our planners, led by **Jay Nichols**, for having the foresight not to try to repeat the beach parties that highlighted the two previous reunions. Sixty classmates attended all or part of the events. Jay has now retired from reunion planning, and our new slate of officers are: **Rick Lufkin**, president, **Ken Theriault**, vice-president, **Ken Morse**, 25th reunion chairman, and the undersigned as secre-

tary/treasurer. We are starting the planning for the super gala 25th reunion even as we write this and will notify of a date to reserve shortly so you won't have any conflict.

Bob Metcalfe, who was unable to make the reunion at the last minute, was recently honored by the IEEE with the Alexander Graham Bell Medal for exceptional contributions to the advancement of communications sciences and engineering. After receiving a Ph.D. from Harvard, he joined the Xerox Palo Alto Research Center where he was one of the inventors of the Ethernet, a local area computer network. He then founded 3Com Corp. to commercialize this and other related technologies and has seen the firm grow to over 1,000 employees. Bob lives in northern California with his wife, Robyn Shottwell, two dogs, and the newest addition to their household—a daughter born in 1987. . . . **Estia Eichten** has been elected a fellow of the Division of Particles and Fields of the American Physical Society "for pioneering contributions to the understanding of quarkonium spectroscopy and for comprehensive studies of 1 TeV scale."

In Clearwater, Fla., **David Ellis** is practicing law and specializing in computer law, copyrights, and trade secrets. He has authored a book entitled *A Computer Law Primer*. . . . After getting a doctorate in chemistry from Princeton in 1973, **Emil Friedman** "regressed" to a master's in statistics from Case Western in 1987. . . . **Peter Lobban** has been promoted to manager of Computer Sciences at Sequoia-Turner Corp., a manufacturer of hematology instruments.

And finally, **Reynold Martin**, who was part of the reunion planning team, has been named business unit manager for General Foods' Flavors & Ingredients Business in Woburn. He is also finishing up an evening program in administration and management at Harvard. . . . That's all we have for now, but why don't you take this opportunity to drop us a line about what you have been doing (or write for your spouse if he or she won't).—**Gail and Mike Marcus**, Secretaries, 8026 Cypress Grove Ln., Cabin John, MD 20818

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In early June I met with fellow ex-Burtonite, **Ora Smith**, who was visiting the Boston area on business. Ora, now director for External Technology Development at Rockwell International, lives in Thousand Oaks, Calif., with his wife, Sue, and sons, Everett and Nathan. At lunch at the M.I.T. Faculty Club, we reminisced about school days and the evolution of fellow classmates. We both felt the presence of father time as we recalled friends who were no longer with us.

Days later, the U.S. mail brought news of another death. **Marcellus Jack Anderson, Jr.**, died on April 24, 1988. From the obituary printed on the funeral notice from the Ebenezer Baptist Church of Austin, Tex.: "His life was marked by numerous professional achievements, a dynamic personality, and many unselfish contributions to his community." Jack earned an S.B. in management from M.I.T. and his M.B.A. from Harvard in 1977. Following his work as a marketing manager for IBM in Washington, D.C., he returned in 1979 to the family business in Austin and began a successful career as an investor for Anderson-Wormley Real Estate. He is survived by his parents, Ada and M.J. Anderson, Sr., a sister, and aunts and uncles from California to New York. The church notice says, "Contributions in lieu of flowers may be sent to the Multiple Sclerosis Foundation or the Center for Attitudinal Healing."

Turning to good news, **Anthony K. Lima** is now president of Pacific System Design Workshop, Inc., one of 18 software development companies selected by Ashton-Tate to work with an advance copy of their new product, dBase IV. He is also under contract with Addison-Wesley to publish a book on dBase IV, scheduled to appear in January 1989. The new book follows two earlier

ones on dBase II and III. Tony is a noted lecturer on dBase III PLUS and is a professor at California State University, Hayward, in the Business and Economics Department.

Henry G. Baker writes, "I have finally joined the ranks of the 'money pit' owners with the purchase of a California-style house, complete with pool, dog, etc. My two-year-old consulting business (Synapse Computer Services) with venture capitalists and small entrepreneurial companies continues to grow. I was recently elected to the board of directors of Megagraphics, Inc., a fast-growing manufacturer of peripherals for the Apple Macintosh. I have also been active with the MIT/UCLA Venture Forum and the MIT/Caltech Venture Forum." He adds, "My masochistic side has also recently been titillated with the notification of not one but two pending SBIR contracts and all of the government red tape that that involves." Nonetheless, "I highly recommend other alumni look into SBIR (Small Business Innovation Research) solicitations. Many of the projects that they are soliciting are delightfully interesting."

A news release from Tufts University indicates that associate professor of physics, **Austin Napier**, and his colleagues are participants in an international physics experiment to detect proton decay, a key prediction of "grand unified theories" of force unification. Tufts scientists are working with colleagues from Argonne National Laboratory, the University of Minnesota, Oxford University, and Rutherford Appleton Laboratory in Great Britain to build a massive underground detector. For up to a decade, they plan to search for proton decay in the "Soudan II" nucleon decay detector, a \$12 million experiment funded primarily by the U.S. Department of Energy and Britain. The detector is located about one-half mile underground in an old iron mine in Tower Soudan State Park in northern Minnesota. The device will also function as a neutrino detector and a detector of muons from cosmic ray interactions in the upper atmosphere.

Some of you may have seen my fine face for six seconds on NBC Evening News last May engaged in a futile effort to "debunk" Nancy Reagan's favorite hobby. Astrology won 90-6, the ratio of seconds of video coverage, pro versus con. And it was three astrologers plus three "high-tech" users of astrology to one humble engineer/science writer. No fair, Tom B.!—**Eugene F. Mallove**, Secretary, 183 Woodhill-Hooksett Rd., Bow, NH 03301

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Douglas N. Gordon and his wife Caryl recently adopted Amanda (age 1) from Korea, who joins Ben (12) and Jed (11). Douglas became vice-president and general counsel to the Specialty Products Division of Hoechst Celanese Corp. . . . **Arthur E. Perkins, Jr.** has joined Ethyl Corp. as purchasing manager, operating materials, in the company's Chemicals Group. . . . **A. Nihat Berker** received a promotion to professor of physics at M.I.T. He received his M.S. and Ph.D. in physics from the University of Illinois, at Urbana Champaign in 1972 and 1977. He was a postdoctoral research fellow at Harvard from 1977 to 1979 and became an assistant professor at M.I.T. in 1979, promoted to associate professor in 1982. Among his research interests is the development of a microscopic theory for the exotic and reentrant phases of polar liquid crystals.—**R. Hal Moorman**, Secretary, Box 1808, Brenham, TX 77833

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As I write this, a heat wave covers most of the country, which hopefully will be over when you read this in October. It is cooler in Florida than in the North, as all my friends up there keep reminding me.

Linda Mayeda continues to pepper her retirement with some marketing research and the occasional fun part-time jobs like working on the Ramesses II exhibit in August in Boston, plus a summer school course in Japanese. She plans to head back to Stow for the winter.

I had a chance to visit with **Gail Thurmond** and her husband Dick and family on the way back to Florida in May. They are doing great, and she was working on opening a store in addition to her medical practice. Memphis seems to agree with her well, and I just missed a great party that they had.

Kathy Kram and her family are happy in Boston but sweating out the wait for the decision on her husband's tenure at Boston University. Kathy already has tenure, so hopefully Peter will have tenure by the time you read this.

That's it for this month's news. I wrote this the end of June, as I was preparing to move to France for the summer or longer, as part of my using my retirement to travel. I will be summering on the Riviera, in Paris and in Bordeaux (have to be convenient to some wine tasting). After the summer, I will travel to visit various friends in Europe and then go on to Egypt and possibly Greece. My return date is uncertain, so I am going to have to take leave of being class co-secretary for a while. Please, while I am gone, send all your notes to our co-secretary, **Dick Fletcher**. Thanks: I know that he will look forward to hearing from you.—**Wendy Elaine Erb**, Co-secretary, 6001 Pelican Bay Blvd., Apt. 1003, Naples, FL 33963

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Scant news to report this month, as everyone recovers from the joyful reunion. I am assuming it was joyful, as I couldn't make it despite being in town briefly on the Thursday of Tech Week.

Jay Benesch has joined GE's R&D Center in Schenectady, N.Y., as a physicist, after being their manager of Systems Engineering in Florence, S.C. . . . **Ken Rosato** was promoted to staff title survey engineer with Amoco in Houston, and is keeping himself amused with TR's Puzzle Corner. . . . **Dan Shalom** is living in Valencia, Calif., and working in the Neurology Department at Kaiser Hospital in Los Angeles. . . . **Tishan Hsu** exhibited his paintings at the List Center in Cambridge in May and June of this year.

We're busy adding a pool at Chapel Hill this summer, and hope to have had some weeks of splashing with the kids this summer when this is printed. Eric ('96) graduated Highland School in June, and begins the grind of high school as this goes to press. JR ('03) is looking forward to the public-school experience after five years in private schools. The rest of us are here as always. Write.—**Robert M. O. Sutton, Sr.**, Secretary, "Chapel Hill," 1302 Churchill Ct., Marshall, VA 22115

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Only three items this time. Here goes: **Bruce J. Davies** was recently promoted to the position of "principal landscape architect" with the firm of CUHZA, Princeton, N.J., a large architecture and engineering firm. . . . **Michael G. Kozinetz**, II married Michelle McDonald in 1987. **Ross Shachter** was his best man. Dick Fletcher, '72, also made it to the wedding, which took place in West Virginia. Michael and Michelle have since moved to Hannibal, Mo., where he is working on the construction of a chemical plant. Says Michael, "Mark Twain's country is great, and we've also spent a bit of time in St. Louis. All is well out here in the middle of things."

And our last item is a little mysterious. All it indicates is that **Charles J. Digate** resigned as senior vice-president, analytic software, from Lotus Development Corp., Cambridge, Mass. The source of this information was the March 18,

1988, *New York Times*. Care to fill us in on your new whereabouts?

And where are all the rest of you? Please write.—**Jennifer Gordon**, Secretary, c/o Pennie & Edmonds, 1155 Avenue of the Americas, New York, NY 10036

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Mail! From **Dan Christman**: "I have trimmed my musical activities back some to make time for much needed work on the house. I am now in two orchestras, one band, church choir, and a five-and-drum corps. Last summer I replaced the roof. In the fall I started work on a concrete patio. This winter and spring I am redoing the electrical systems and remodeling the kitchen." . . . **Fred Walter**, M.D. is "gaining an interest in biology and organic chemistry, at least as far as it relates to brewing. Otherwise, nothing much new. Greetings to all old NSAers." . . . **Jules Morris** is "still chief patent attorney (physics) for the U.S.A.F. Patent Prosecution Office. Moved into a new (old) house in Brookline and am busy renovating. Still a model transit fanatic and member of Bay State Society of Model Engineers." . . . **Tom Downey** is "now with BBN Advanced Computers, Inc., in Cambridge, having transferred from BBN Communications Corp., across the street. I am manager for third-party-software applications for our Butterfly GP1000 parallel processing computer. I am enjoying the job immensely."

G. William Courtright, M.D., is "currently director of medical education and research, Southern California Edison." . . . **Richard Bahr** is "employed as a consulting engineer with Apollo Computer of Chelmsford and living in Cambridge. Current plans include marrying Molly Dinan of Framingham on June 4, honeymooning in Kenya, and revolutionizing the world of computer workstations." . . . **Russell Chipman**: "Received my Ph.D. in optical sciences a year ago from the University of Arizona and have settled in Huntsville, Ala., where I am an assistant professor of physics at the University of Alabama in Huntsville."

Victor Frankiewicz is "currently serving the third of a four-year term as mayor of Bay St. Louis, Miss. The city has a strong mayor form of government, so the job is demanding as the chief executive position. Also active in several statewide government reform efforts and am chairing Mike Dukakis' local campaign." . . . **Dianne Glennon** has "moved from Citibank International as microcomputer coordinator for the Caribbean Basin Division (2.5 years) to Citicorp Real Estate, Inc., also in Miami. Will be involved in construction lending for commercial development. Am active in the Education Council." . . . **Carl Sharon**: "Was married in June 1985 to Christi Reed, a graduate of Dennison University in Ohio. We met at the Lutheran School of Theology in Chicago, where I earned a master of divinity degree in June 1984. Since August 1985, I have served as the Lutheran chaplain at Yale, and as the associate pastor at Trinity Lutheran Church in New Haven. An amazing change from chemical engineering days, but that became too draining and church work too life-giving to do anything else. So here I am! Would like to hear from other SPEs or '76 classmates. Stop by if passing through New Haven."

Lenny Davis, after many years, has written: "It is ten days until my wedding. I have moved to Chicago where I am a senior chemist at Hodag Chemical Corp. I left Monsanto in Akron, Ohio, after nine years to go to the windy city and seek my fortune. My fiancée, Linda Freeman, is from Chicago, works here, and has all her friends and family here, so we decided that I should be the one to move." . . . **Kerry Emmanuel** has been promoted to professor of meteorology in the Department of Earth and Planetary Sciences at the Tute. He was a postdoc at University of Oklahoma in 1979 and was an assistant professor at

University of California, Los Angeles, from 1978-81. He became an assistant professor at the Tute in 1981 and an associate professor in 1985. Congrats! . . . One of our classmates is part of the chase for high temp superconductors. **Richard Withers** was part of a group at Analog Devices studying microwave devices made with these new, revolutionary superconductors.

C. Reed Hodgins was named Rockwell Engineer of the Year, the company's highest honor for technical achievement. He is a senior principal meteorologist at Rockwell's Rocky Flats Plant near Denver, Colo. He was one of 17 chosen in 1988 out of 19,000 engineers and scientists employed by Rockwell. Your secretary is not surprised to see his classmates rise. From my observations, which now span more than 10 years, it is not a question of *if*, but of *how* quickly. I think it is a function of the ability to work very hard, and that life outside the Tute moves for most classmates at a slower pace, giving them a structural advantage.

It is with great sorrow that I must report a letter from **Bob Struth** (a.k.a. Lt. Comdr. Robert Struth, Jr.): "It is with deep regret that I write to tell you that my wife, Donna, was killed in an accident on February 28. I am just now returning to work and testing flying. It has been the shock of my life, but through the loving support of family and friends I have made it this far. I am trying to take life one day at a time. . . . I have found a wonderful nanny to care for our 5-year-old son. He is doing well; in fact, he has been a great help to me. We have made a pact to take care of each other. . . . Enclosed is a poem Donna wrote. I want to share her talent—I feel it very appropriate to do so:

*You traded in your snow white steed
for a shiny silver jet.
Your armour is a flight suit now
with a colorful helmet.
You race across the clouds on high
instead of on the ground.
Your speed is something to behold
it's faster than your sound.
Just as in the Round Table days,
you quest to fight the foe.
Time hasn't changed your purpose
or the bravery you show.
Your battles may not last as long
as they did in yesteryear,
But your fighting prowess now is such
they're much deadlier I fear.
The spirit of King Arthur lives
as it did in days gone by.
I dub thee now Sir Robert,
my noble Knight of the Sky.—Donna Struth*

Our deepest condolences go out to you, Bob. As for your secretary, by the time you read this, I will have come nearer to closing on a house in Woodmere, N.Y. We have sold out of Forest Hills and are renting in Woodmere while shopping for a house. We are becoming suburbanites after a rather long time living in cities. Woodmere is reminiscent of parts of Brookline. I have found the process of buying and selling real estate slow and frustrating. I prefer futures — faster and a lot easier. On the topic of futures, this election year has helped business by increasing uncertainty and, with uncertainty, the need and desire to hedge. Among the big movers: crude oil, foreign exchange, bonds, and gold. Some markets never rest. A corollary to this is that I do not rest much either. I have been forced by rapidly changing events and markets to carry a portable cellular phone onto the Long Island Railroad from which I broker gold and foreign exchange for clients during the period the train ride spans the opening of these markets in the U.S. I love the technology, as the phone weighs 30 ounces including batteries. The technology redefines how we do business. I have gotten used to the occasional stares.

Please write. We can always use the news.—**Arthur J. Carp**, Secretary, Stalco Futures, Inc., 254 West 35th St., 16th floor, New York, NY 10001, (212) 736-1960

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Adam, first child of Risa and **Eliot Goldstein** was born on January 22, 1988, the same date that Eliot's architectural project, the design of Edmondson Residence in Vermont, received recognition in two professional journals. . . . **F. William Morris'** son, Andrew William, was born June 3, 1987. William is the head of the design department for a large architectural firm in Washington, D.C. He recently moved into his first house, a real "handyman's delight" in Chevy Chase, and he has been working on it ever since. . . . **Steve Bader** and his wife, Angela, a staff anesthesiologist at Brigham and Women's Hospital in Boston, were expecting their first child in July. Steve is still directing a dental center with a staff approaching 70 people in Burlington, Mass.

Geoffrey Landis finished his Ph.D. in physics at Brown and is now working on solar cell research at the NASA Lewis Research Center in Ohio. . . . **Leslie Faye Sutton** is currently an advisory programmer in the Computer Science Department at IBM's T.J. Watson Research Center in New York. She is also studying part-time toward a Ph.D. in computer science at Polytechnic University. . . . **Steven Grossman** reports that he is still at Advanced MicroDevices but is now running the Marketing Department for the Non-Volatile Memory Division. He says, "That's \$150 million a year of EPROMs and E²EPROMs. Loads of fun."

Ed Cluss invites old friends passing through northern California to look him up at his new address: 253 Highland Ave., San Carlos, CA 94070, (415) 594-4866. The house, which he bought in October 1987, sounds great—in the hills 25 miles south of San Francisco with two decks that get a lot of sun and a view overlooking a park. Ed is now manager of product marketing at Aspect Telecommunications, a position he took after leaving Rolm in June 1987. . . . Another California denizen is **Paul Menard** in Sacramento. He took a position with PC/M Group, Inc., as vice-president in October 1987 and in February of this year became 10 percent owner. PC/M offers architectural and construction services. . . . **James Pollock** joined Integrated Systems, Inc., in Santa Clara as the CASE product manager in May 1987. He is involved in developing computer-aided software engineering tools for real-time software development. . . . And to complete our California classmates, we catch up with **Robert Russ, Jr.**, in Los Altos. He founded Unity Systems in 1983 and spent two very difficult years keeping it alive. Now the company has become a leader in the emerging industry of home automation. They are developing a touchscreen based system to control room-by-room temperature, security, lights, appliances, and telephone access. He expects the next few years to be very interesting and challenging.

Moving back to New England, we find **Matthew Sherman** on staff at the Dana-Farber Cancer Institute and Harvard Medical School. He is enjoying research, both laboratory and clinical. His wife, Janet, is a research scientist in M.I.T.'s Cognitive and Brain Science Department. They have two daughters, 9 months and 3 years, and they live in Boston. . . . **Howard Boles** has a lot of news: "I've just started a new job as a software engineer at Technical Data International in downtown Boston, where I'm programming financial investment software. It's a switch from my previous engineering R&D environments, but it's stimulating nonetheless. I'm also still active in community theatre, having music-directed a production of *Man of La Mancha* at the Vokes Theatre in Wayland, Mass., last fall and having just finished playing synthesizer for a production of *Little Shop of Horrors* in my hometown of Marlborough, Mass. My wife, Lisa, is still busy as ever as a filmmaker, having just optioned an original screenplay with a Hollywood producer. (I'll let you know if this ever develops!) And my daughter, Bethany, who's almost 2, is doing great—walking and talking up a storm!" . . .

Julian West spent all last year building a new house on a lake in southern New Hampshire. He is now working at Data General after his previous employer, Can-tel, folded with only 24-hours notice!

Moving down to metro D.C. finds **Phuong Trinh** living in Rockville, Md., and in private practice in infectious diseases in Montgomery County. . . . **David Batchelor** in Greenbelt, Md., is the solar acquisition scientist at NASA's Goddard Space Flight Center. He acquires solar data from space missions for the National Space Science Data Center. . . . And then there's me, spending more money on tuition for my daughter's first grade Montessori program than we spent either our freshman or sophomore years for tuition at M.I.T.! Hard to believe, isn't it? And then my son will be attending a cooperative preschool two mornings a week as well. Maybe I ought to get a job. . . hmmm.—**Ninamarie Maragioglio**, Secretary, 8459 Yellow Leaf Court, Springfield, VA 22153

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After ten years of being secretary, how does one begin his last class notes column? How about with the news?

This month's biggest news is our 10th reunion, a smashing success—over 120 members of the class came accompanied by more than 80 various spouses, children, and significant and insignificant others. (Were YOU there?) Put in a nutshell, the turnout tops nearly every other class for about 50 years. Kudos for a great time and a great job go to the Reunion Chair **Karyn Altman-Velazquez** and organizers **Regina Murphy**, **Frank Murphy**, **Phil Kesten**, **Cindy (Hussman) Berman**, **Jim Bidigare**, **Diane Curtis**, **Frances Scovil**, **Joan Olson**, and others. (And I get a gold star for showing up to all the committee meetings.)

Besides partying, we also conducted a little business at reunion—electing new officers. Our fearless leaders for the next five years (at least) are **Milt Roye**, moving from class agent to president; **Phil Kesten** was made vice-president in reward for organizing the reunion Red Sox game; **Jim Bidigare**, our class president for the last ten years has now stepped up to become secretary; and **Diane Curtis**, formerly our class agent, will now be our treasurer. Congratulations and good luck to you all.

Now for news from the folks back home. Weddings: talk about quandaries—if you get married in Hawaii, where do you go for your honeymoon? **Gary Tom** and his high school sweetheart, now wife, **Paulette Fujimori** solved that problem last December by taking a cruise in the Caribbean. Now they're back home in Cupertino, Calif., where **Gary** works for Tandem Computers. . . . **Mark Tannen** writes that he got married last September to **Cecilia Candelaria**, with **Jeff MacAllister** as best man. "After the wedding we returned to Torrance, Calif., to unveil new versions of 'Scriptwriter' and 'Storyboard' for the Apple Macintosh II, published by my company, American Intellware."

Thomas D.Y. Chung writes of his engagement to **Barbara Pritchard** (slated for last May, honeymoon planned for Hawaii—where else?). **Thomas** is currently doing an industrial postdoc fellowship with **Smith Kline & French Labs** in King of Prussia, Pa. . . . **Celeste Satter** has "had a lot of excitement and changes since leaving Berkeley. I spent the last two years on a postdoc in Sweden, got married in February 1987; now working at JPL in Pasadena. What's next, children? What a change that would be!"

Speaking of children and changes, there's **Rich Ware**. After nine years in western Massachusetts, **Rich** recently moved to southeastern Massachusetts, bought a condo, married **Marian Hildebrandt**, (only recently discovered to be a long lost second cousin), and now lives with **Marian** and her 11-year-old daughter **Molly** and their new baby **Paul**. **Rich** has a new job with old

friends at **Verbex** in Cambridge making a speech-recognition computer peripheral. (The entire **Ware-Hildebrandt** family was at reunion.)

I've received four boring postcards this month. **Julie Kozacka** sends one from Antigua of a boring game—cricket. **Julie** writes: "The postcard's not exactly boring, but the cab drivers here have an amazing tolerance for radio broadcasts of this game! (We tourists prefer the beach.)" **Julie** was also the author of a riotous reunion survey, "are you a seventies kid?" (Copies are available at my address, below.) . . . **Rich Perlstein's** latest addition to my boring postcard collection comes from **Palm Springs, Calif.**, showing natural beauty clothed entirely (though scantily) in synthetic fibers. **Rich**, who came in from **Oakland, Calif.**, for the reunion, is working as an architect in **San Francisco**. . . . **Ed Nadler** sends a postcard (a ghastly crowded beach in Tel Aviv). After two years of postdocs, **Ed** is now a professor of mathematics at **Wayne State University** in **Detroit** teaching and continuing his research into "multivariate spline functions." **Ed** and wife, **Eileen**, now live in **Birmingham, Mich.** (the same town that our new class president lives in). . . . A fourth postcard, from **Bubbles**, (a.k.a. **Alan Presser**) is better left undescribed. **Al** sent the card from exotic **Lynnfield, Mass.**, where he and his wife, **Dorothy Anderson**, just bought a lovely new house. . . . **Bill McGrath** writes, "Thanks to **Brian Berkeley** for sending all the Mt. Fuji postcards. I hope he visits some place else soon." (I'm jealous.)

Medical records: **Paul Okunieff** is now a physician in radiation medicine at **Mass. General Hospital** right across the river from **M.I.T.** "I'm doing research in high resolution nuclear magnetic resonance of tumors, hoping to develop assays predictive of tumor treatment response." . . . **Jeffrey Snow** is just finishing up his surgical residency in **Albany, N.Y.**, and is now moving to **Erie, Pa.**, for further specialty training. . . . **Paul Babyn** dropped us a note just as he was finishing a fellowship in pediatric radiology at the **Hospital for Sick Children** in **Toronto**. He adds: "The family is growing by leaps and bounds—now two little ones under foot."

Michael Nathan writes: "I'm enjoying residency in internal medicine in **Rochester, N.Y.** (as much as one can). I'll be chief resident here in 1989-90, and that looks very exciting." **Michael** will be getting married this October to **Michele Walczak**, whom he met in med school. . . . **Manuel Casiano, M.D.**, wife **Carmen** (also a physician) and their 2-year-old **Christopher** are now living in **Frederick, Md.**, where both **Manuel** and **Carmen** are in private practice.

I got a note in four different handwritings from **Cameron Moss**, reporting that he and his wife **Susan** had a baby boy (**Devin**) in **February 1987**. "He's getting ready to walk and run his parents ragged." The **Mosses** are moving back to **Munich, W. Germany**, where **Cameron** will work for **McKinsey & Co.** . . . **Gregory Mayhew** wrote to announce receipt of his Ph.D. in electrical engineering from **University of Southern California**. **Greg** is now a staff engineer at **Hughes Aircraft** in suburban **Los Angeles**. . . . Also in the neighborhood of **L.A.**, is **Maurice Halmos**, who's working on a Ph.D. in quantum electronics/electrical engineering at **UCLA** under a **Hughes** doctoral fellowship. . . . A note from **Aaron Endelman** informs us that he is now in his third year as a software engineer with **Sun Microsystems** in **Palo Alto**, specializing in developing symbolic programming environments. . . . **Bernard Alpern** writes to announce his appointment as manager of the new **Manhattan** office of his company, **Comsis**, a transportation consulting firm.

What's six-foot-six, has three degrees from **M.I.T.** and makes a . . . ahem . . . spectacle of itself at nearly every **Red Sox** home game? Some call it "the bleacher creature," some call it "professor," but we know it as **Paul Lagace**. **Paul**, when he isn't trying to set the world's record for the longest and loudest cheer for **Red Sox Third**

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Baseman WAAAAAAAAADE Boggs (best so far: 24 seconds) is a professor of aero and astro at M.I.T. His chewing-gum baseball card (no joke) states: "Also known as Psycho II, he has had not-quite-starring roles in the Red Sox highlight film, *This Week in Baseball and Sports Spotlight*. He has also attended 500 plus games."

Mary Kappus writes: "I'm finally getting in some sea time, although I had to leave the navy to do it. I spent several months in the equatorial Pacific doing (explosive) geophysics research, loosely connected to my Ph.D. studies at Scripps Institute of Oceanography in San Diego. I hope to publish soon in *JEST (Journal of Equatorial Seismology and Tectonics)*. Parts in Guatemala and Acapulco were fabulous, but now I need to learn Spanish, too." . . . **Kathy Keilmeyer** writes that she has been promoted to manager of the Computational Analysis Section at TASC. In addition, she's working on her master's in systems engineering at night.

And now, for our latest installment of gobbledygook from **Dick Field**. (Actually, I think I'm being used to send top secret information to the Dalai Lama's forces in Tibet.) Here goes: "BLOME to Nino. I see pio. Hy-Jean! Are there any more lobsters at NRSA?" When not writing secret code, Dick writes computer code as a senior software engineer at Metagraphics in Woburn, Mass. Dick and his wife Donna were expecting their first child when he wrote.

Now for my gobbledygook. The astute amongst you will have noticed at the beginning of this column that I have stepped down as your secretary after a ten-year sentence. I do so with some regrets, as being secretary has been a lot of fun, not to mention a great excuse not to write letters—"just read about it in my column." But after ten years, it's time to start writing my own letters again and to pass on the torch.

For those of you addicted to serial soap operas, I promise to keep you informed via this column of the continuing saga of David and Yuko. In our latest episode, David gets a promotion to planning projects manager, only to have the entire department moved under a new vice-president. What havoc will reorganization reap? Stay tuned.

The burdens and pleasures of gossiping with all of us now passes to outgoing class president, **Jim Bidigare** (double entendre intended). So, let's all give him a rousing welcome, by burying him with voluminous piles of news, gossip, gobbledygook (that means *you* Dick), postcards, junk mail, short novels, and true romances at 659 Green St., Cambridge, MA 02139. You'll love it, Jimbo.

Thanks to all of you for writing and reading for the last ten years. Don't be a stranger: feel free to write. Now I have no excuse not to write back. And, of course, I'll always welcome boring postcards. It's been a pleasure.—**David Browne**, Secretary, 50 Follen St., No. 104, Cambridge, MA 02138, (617) 491-5313

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Not much news this month, folks. Time to get out those pens and pencils (and word processors) and drop me a line, or else I'll have to go back to making up things about you.

John Barr decided to catch us up on the last nine years of his life. He writes, "The first four years after graduation were spent on a paid vacation in Europe (although the army still insists that I was gainfully employed at the time), and the following two were devoted to aimless wandering in various parts of Europe and the Mediterranean. I finally decided that it was time to grow up but fortunately changed my mind and entered graduate school instead. I'm currently at Pennsylvania State University in the Computer Science Department and am in search of the Holy Grail of Graduate School—a thesis topic which is exciting, relevant, useful, and doable within my lifetime. Projected graduation date is two years or when I reach 65." On the home front, John and wife Susan Flint, '81, have a

1-year-old daughter, Gwendolyn, and are expecting twins in September. "I probably won't make the reunion next year, as the thought of traveling to Boston with a 2-year-old and 7-month-old twins in a closed container is daunting."

David Soule is "still working for Cyanamid as a production manager in the Niagara Falls, Ontario, plant. Playing tennis and racing sailboats on Lake Ontario for fun." . . . **Gerald Mata** is living in Stoneham, Mass., and working at Boston Edison as the administrator of project scheduling and budget control. . . . **Beth Marcus** has turned up at Arthur D. Little's Center for Product Development in Cambridge as one of the media contacts for the medical products industry.

At the May meeting of the ASNE (American Society of Naval Engineers?) in Washington, D.C., **David Maurer** was one of a team of three who spoke on "A Modularized Shipboard Helicopter Support System." I hope the talk really "took off!" . . . A public relations release announces that **Thomas Theurkauf** has been appointed director of investor relations for Shawmut National Corp., the new super-regional bank holding company. Theurkauf, who is also a vice-president of Connecticut National Bank, a principal subsidiary of Shawmut National Corp. will report to the vice-chairman." He has been with Connecticut National Bank since 1981, after receiving his M.B.A. from the Amos Tuck Business School at Dartmouth.

Two classmates have hopped aboard the tenure track at the Tute. **James Fujimoto**, who remained an M.I.T. student until 1984, picking up a master's and a Ph.D., has been appointed an associate professor of electrical engineering. He has worked and published in several areas with colleagues at the Research Laboratory of Electronics at Mass. General Hospital. . . . **William Weihl**, who also finished his M.I.T. studies in 1984 with a couple of S.B. degrees, an S.M., and a Ph.D. under his belt, has been appointed an associate professor of computer science and engineering. His area of research is the theory and design of distributed computer systems, and he is known for his work on concurrency control and recovery algorithms, on formal models for transaction systems, and on the Argus programming language and system. . . . **Brad Myers** graduated from the University of Toronto in May 1987 with a Ph.D. in computer science. He is now a research computer scientist (which he likens to a research assistant professor) at Carnegie Mellon University in Pittsburgh, where his wife's family lives as well. They have a 2-year-old son and another child expected this October.—**Sharon Lowenheim**, Secretary, 500 E. 63 St., Apt. 18B, New York, NY 10021

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Hello everybody. We are a little slow in the news department this month. Maybe it's a good time to write!

We did hear from **Jeff Oehler**. Jeff and his wife Mary Britt Oehler, '82, graduated from Ohio State University Medical School in June. Both will pursue internships and residencies at Ohio State. Jeff will specialize in ophthalmology, and Mary will study radiology. Jeff hopes to be in a "real job" by the time he reaches 35! Congratulations.

Connie Bair-Thompson has moved once again. They left the Boston area to relocate outside of Pittsburgh. Connie says that the costs of living and housing are pretty low and that the city exceeds its reputation. She and husband Randy are enjoying it. Connie is working for Tippins Inc., automating metal industry plants specializing in electrical/electronic control systems.

Nicholas Kojey-Strauss is currently a research supervisor at Young and Rubican, a New York advertising agency, and enjoys following the performance art scene in the area.

I received a press release from Epoch Systems, in Marlborough, Mass., where **Steven Glassman** is a principal software engineer. My desk is clear. That's all for now. Please write soon.—**Lynn Rad-**

lauer Lubell, Secretary, 216 Beacon St., Boston, MA 02116

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Joseph Kristl reports that he's been working on infrared measurement and models since leaving M.I.T., first spending four years in the air force flying on a KC-135 flying infrared laboratory and participating in infrared measurement programs for the Department of Defense. He then spent one and one-half years developing infrared sensors and instrumentation for Utah State University and is now employed by Ontar Corp. in Brookline, Mass., developing infrared cloud and background models. . . . Since receiving an M.S. in computer science from New York University in 1987, **Richard Amster** has been consulting and thinking about molecular scale engineering. He's also a pilot and aircraft owner.

Keith Perkins recently quit work for the fun of full-time graduate school in materials science at the University of Wisconsin. He hopes to finish in three years. . . . Another classmate who's gone back to school is **Ralph Inglese**, who's getting a master's in management at Northwestern. Ralph writes that he really likes Chicago.

Well, so do I. I've just begun a one-year sojourn in Chicago with **Ken Snow**; we'll head back to Boston next July when Ken begins a fellowship in endocrinology at Tufts/New England Medical Center.

Remember, it takes six months from writing to publication if you correspond through the Alumni Association when you make a contribution. Speed things up by taking a moment to write or call East Coast correspondent **Linda Schaffir** (18 Prospect Ave., Apt. B-2, Norwalk, CT 06850), West Coast correspondent **Michelle Gabriel** (656 S. Fair Oaks Ave., D-211, Sunnyvale, CA 44086) or your new Midwest correspondent.—**Stephanie Pollack**, 722 W. Roscoe St. #204, Chicago, IL 60657-6509

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Those who attended our 5th reunion can attest that it was truly a spectacular event. Our agenda included Thursday night at the Pops, a party at the Boat House on Friday, dinner in Chinatown followed by a party at the Delt house on Saturday, and the Sunday morning brunch. All of the events were well attended, and we should thank **Hyun-A Park** and the reunion organizing committee for a most enjoyable weekend.

And now for an update on our classmates. **Eric Tiffany** was wed on April 23 to Lee Park (Wellesley, '86). Eric has been spending his time planning his wedding and seeing to it that his recently-formed company gets off the ground. Eric helped co-found Ascent Technology, an artificial intelligence start-up in Kendall Square. Eric says that business is great and that he and Lee are now racing to see whether Lee gets her Ph.D. in chemistry from M.I.T. before Ascent Tech makes it into the Fortune 500. May the best spouse win!

Ji Hong has decided to work at Shearman and Sterling in New York since he graduated from Harvard Law School. . . . **Barry Margolin** has been working for Thinking Machines and donating quite a lot of money to Tech. (Great job Barry, we'll look for you at the next LSC movie). . . . **Henry Gonzalez** tells us he is currently employed by the Naval Coastal Systems Center of Panama City, Fla., but currently is in the middle of a one-year assignment as the R&D branch head of the Chief of Naval Special Warfare Division of the Pentagon.

Mark Dewitt decided to give up Course II (urban studies) and computer programming at Computer Corp. of America. He is now enrolled in the master's program at the New England Conservatory of Music. . . . **Tom Grycwicz** just bought a new truck, a four-bedroom house, and

a forest. He was also promoted to captain and is now teaching at the U.S. Air Force Academy. . . . **Erik Hjerpe** no longer rows crew, however he no longer has to. He is currently the resident officer in charge of construction at the naval airstation at Patuxent River, Md. . . . **John Jordan** is still rowing crew with **Tom Woods**. John is building satellites for Hughes.

David Brackman has changed his name to David Segal-Brackman, thanks to his September marriage to Debra Beth Segal. Debbie still works with Professor Sheldon in the Biology Lab, and David is still at Wang Laboratories trying to save the company with their yet-to-be-announced next-generation word processing system. . . . **Jean Swecker** wanted to do something different, so she left the air force and opted for the poor student route at the University of New Mexico. She confesses that, although the engineering curriculum is ho-hum, the skiing is fabulous. At least she has her priorities straight. . . . **Ya-Pei Chang** is now Ya-Pei Holden. As of April 23 (popular date), Ya-Pei married **Ray Holden**, mechanical engineering. Ya-Pei is now working for the Jet Propulsion Lab.

Adam Zilinskis is now working on logic synthesis for a start-up CAE company, Silk Technologies. . . . **Kei Mu Yi** will soon have a Ph.D. from the University of Chicago Economics Department, however if his graduate volleyball team does not win next year's intramural championship, he will probably drop out of the program. . . . **John Pionti** is contemplating a career change after working several years for the Massachusetts Water Resource Advisory Board. John and fiancée, Susan Andrews (Wellesley, '84), have just bought a farmhouse in Maine and should have the place in shape by the fall party season.

Robert Norwood, member of the big rock group, The Clockmen, is convinced that one day he will get his Ph.D. from the University of Pennsylvania but will probably be married before that time. In fact, Robert is engaged to be married in December to Mary McDonnell from Drexell Hill, Pa. . . . **Charles Quintero** is really into the Star Wars thing. He is working on the MC68020 for the Sea Wolf attack sub, and the AEG15 APY-1B radar. He must be doing quite well, as he was awarded the Chief Engineer's Technical Excellence Award from VLSI. . . . **Rob Boyle** is elated to be working at NASA's Goddard Space Flight Center. He is also very happy to be married to Marilyn Mahoney (Wellesley, '86). They are currently living near Baltimore, where Marilyn teaches high school history and Rob plays the mad scientist.

John Friedman finished his master's from University of Wisconsin in oceanography and has been working as a wetlands ecologist for the Nature Conservancy. In his spare time, he teaches bio and environmental science at a local community college in the Seattle area. . . . **Dennis Doughty** has recently completed his trip to Wimbledon with his new wife, Carol Rosenstock (Brown, '82). There was plenty of Tech representation at the wedding, including Warren Barger, '82, **Adam Blonsky**, Duane Boning, '84, Tom Davis, '84, and Andy Gruder, '81. . . . **Robert Dimmig** gave up aero/astro and will settle in Boston, New York, or Washington after he completes his master's in urban planning.

John Armstrong is currently working at the University of Cologne in West Germany as a radio astronomer. . . . **Ken Segal** finally finished medical school in June 1987, and is currently doing an internship at Mt. Sinai Medical Center in Cleveland. Next year he is off to Houston for a residency in radiology. . . . **Allen Frechter** finished Sloan in June 1987, and is now living in New York City and working for Reuters, Ltd.

We hope to see **Marc Fenton** this fall in Seoul, Korea. Marc is currently at the Olympic Training Center at Colorado Springs, training for the 50K Race Walk trials. He is currently ranked seventh in the U.S. In his spare time, he is working as a researcher/programmer at the USOC Biomechanics Lab. Marc is still on leave from his master's in mechanical engineering at M.I.T. . . . From the

West Coast, we hear from **Brian Jacobs**, who is spending the summer at Security Pacific Ventures before going back for his second year at Stanford Business School. Brian's classmates include Albert Pleus, '84, Pamela Mitchell Pleus, '84, and Jeff Green, '82. Brian regularly sees **Chris Schneider** and **Ken Krugler**, who have their own company that develops Macintosh software for the Japanese market. He also sees **Mike Santullo**, who works alongside **Kristin (Kinta) Foss** and Mark Farley, '84, at a Raychem subsidiary called Raynet.

Karl Zimmerman now sings with the Harvard Radcliffe Chorus. By day he is a software engineer at Prime. . . . **Jonathan Sandberg** is an associate at Clement Associates, part of ICF, which is the U.S.'s biggest environmental consulting firm. . . . **Edmund Austin** is thinking of giving up the Jet Propulsion Lab in Pasadena and going for his M.B.A. . . . **Anita Honkanen** is still with the marine corps and is heavily involved with long-distance running. . . . **Denise Roberts (Brush)** is currently working as a software engineer for Boeing in Seattle.

Jennifer Melcher was the first recipient of the UNISYS Fellowship. Jennifer is still a doctoral candidate in Department of Electrical Engineering. Maybe she will even stay on at M.I.T. and become a member of our faculty. . . . **Ron Sticinski** is employed as a quality engineer with Intermarine U.S.A. and is working out of Savannah, Ga. . . . **Neil Webber** recently joined start-up Epoch Systems as a senior software engineer. . . . **Eric Lipson**, recently graduated from the Bowman Gray School of Medicine at Wake Forest. He will train in internal medicine at Jackson Memorial Hospital in Miami. . . . **Leslie Virany** is now living in Ottawa, Canada.

On a sad note, I regret to inform you of the death of Lt. **Charles R. Souter**. Lt. Souter, who was employed as a navy ROTC teacher at M.I.T., received his degree in mechanical engineering. He was killed in a car accident in New Hampshire on May 25. He is survived by his wife, Alice, and his family in Andover, Mass. Contributions may be made to the Andover High School Athletic Scholarship Fund.

My thanks to **John De Rubeis**, who has served us as class secretary over the past five years and who generously contributed the majority of this month's column. John writes that he is still having a lot of fun working for Big Blue in marketing. He has also pledged to contribute to our class notes for years to come.

As for myself, I am finishing up two years at TA Associates, a Boston venture capital firm, before shipping off to business school in the fall. I look forward to serving you as class secretary and hope you will find time to write and keep us all informed.—**Jonathan Goldstein**, Secretary, 2 Soldiers Fields Park, No. 201, Boston, MA 02163

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Hello again, classmates. This month's news is pretty slim. More of you need to write or call in good gossip. Plans for the reunion are under way, but we still need volunteers in the Boston area to help out on the committee. Please let me or Eliza Dame of the Alumni Office know if you would like to join. Here's the news. . . .

I went to a benefit for the Make-A-Wish Foundation last May. They are a group who grants wishes for terminally-ill children. There were several celebrities there, including Nels VanPatten, Christopher Atkins, Erin Grey, Gil Gerard, Grant Goodeve, David Leisure (Joe Isuzu), and Richard Hatch (who is one of my all-time heart-trobs). I couldn't resist the opportunity to have my picture taken with him (see photo). I think we make a lovely couple. . . I'll let you know how things progress.

Alex Gruzen is beginning the Harvard Business School M.B.A. program in September, as is **Kevin Mayer**. Alex has spent the last year building his own race car and will be racing throughout the



Richard Hatch, of Battlestar Galactica fame, and Diane Peterson, Class of 1984 president.

northeast this summer and fall.

Lesla Aylward was married in February to Steve Warner. She is working for an environmental consulting firm in Washington, D.C. . . . **Charles Kimball** married Lois Annette Simpson in 1985, had a daughter named Alicia Grace in 1986, and joined the Church of Jesus Christ of Latter Day Saints in 1987. Other than that, he is enjoying life with a family. . . . **Frank Slaughter** married Mimi Ing, '87, in June. Tons of Kappa Sigs and Alpha Phis showed up for the wedding.

Vivian Kim writes that she and **John "JT" Taylor** graduated from the University of Pennsylvania School of Medicine in May. JT will be doing a surgery residency at Montefiore-Einstein Hospital in New York City, where his wife Maria is a buyer for Macy's. Vivian will be doing her residence in anesthesiology at Mass. General Hospital in Boston (after she does a one-year medical internship in Philadelphia).

Mark and Shelle Ensio write that several classmates were in Houston in April for the wedding of **Kim Coldwell** to Frank Worley. Those in attendance were: **Ann and Jeff Berner**, who are new homeowners and working for Boeing in Seattle; **Carl Adams**, who is finishing his first year at NASA in Houston; **Dave Walters**, who is working for Boeing in Seattle; **Eric Alani**, who is continuing his Ph.D. work at Harvard in biology; **Larry Murphy**, who is working in New York for Ciba Geigy and traveling the globe; and **Nancy, '87, and Vinnie Natoli**. Nancy is working on her thesis at M.I.T., and Vinnie is working at Mass. General Hospital while deciding on which school he will attend for his Ph.D. in physics. Meanwhile, Mark is president of an abrasives manufacturing company, while Shelle spends her days with their 1-year-old daughter, Anja. They live in Houston.

Oren Levine writes from Petah Tikve, Israel. He left General Motors (and Detroit) in August 1987 after three years as a safety and crashworthiness engineer. His destination was Israel, where he has been since last October. He went to do a work/study program at the WMJS Institute. The first five and one-half months were spent at the Institute in Arad, a small town near the Dead Sea. He learned Hebrew and other Jewish stuff and traveled around the country. He met people from around the world, but mostly Americans! After the stay in Arad came the work part of work/study. He found a job as a mechanical design engineer for a small firm called Indigo, which does a variety of R&D work in photocopying and related technologies. Indigo is located in Rehovot, home of the Weizman Institute. He was in his second week there when he wrote and did

Composer, Hydrologist, Actor, Geologist

By Jonathan Richmond, G



Killian Hall would be packed for the concert, mostly with wildly enthusiastic M.I.T. students—even though finals loom just around the corner. But this is just the rehearsal.

Julio Friedman, '88, grips his chair, aiding and abetting the laws of gravity to hold himself down; but to no avail. With a burst of energy, he bounds toward the stage to exhort and excite his performers into entering his special world. It's the day before he presents his senior thesis: the May 11 Killian Hall recital of his compositions by singers and instrumentalists from the M.I.T. community and beyond.

JONATHAN RICHMOND is working towards his Ph.D. in transportation planning at M.I.T. and is a music critic for the Christian Science Monitor.

"No wonder that sounds strange; I forgot to give you two sharps in your part," he tells the flautist. Julio's mentor, Assistant Professor of Music and Theater Arts Peter Child, sits at the piano with a calm bordering on the phlegmatic. During a brief lull in Julio's creative chaos, Child gently offers a suggestion of his own. Julio nods agreement, then bounces backward, compressing his springs a bit too far. He waltzes forward again for a brief additional rejoinder, then bonds himself to his seat once more as the rehearsal continues.

Composer, hydrologist, actor, geologist, Julio burns fuel at a furious pace, but M.I.T.'s environment keeps him fully stoked. It's his final term, he's won the Laya and Jerome B. Wiesner Prize for Artistic Achievement from the music and drama faculty, he's preparing for the first

senior composition recital at M.I.T. in 15 years, is enrolled in seven subjects (in earth sciences, ecology, and fluid mechanics—in addition to music), is tutoring two high school students in algebra, geometry, and chemistry, and is looking for a job. "Of course, it's too much to do all these things at once," he says. "It's impossible to be a student at M.I.T." But he clearly wouldn't have it otherwise.

The roots of Julio's composing career go back to eighth grade, when he "simply couldn't tolerate piano lessons any more. I had no discipline at all, but I loved playing the piano, so I began fooling around, composing." His introduction to science came even earlier: the five-year-old Julio had a piano teacher whose husband polished rocks for various purposes. After his lessons, Julio would go out and

watch him work. He grins as he makes the connection to his M.I.T. XXI-S major in Humanities and Earth and Planetary Sciences.

The Institute was appealing, not only because of its scientific reputation, but because Julio knew that "M.I.T. had a fine Shakespeare Ensemble, that the music faculty was very strong, and that there were some very sharp performing groups."

This notwithstanding, he left high school confident that he was a "hotshot scientist and mathematician" and convinced that a career in physics beckoned. It took all of two weeks of 8.012—"Physics for Masochists" he calls it—to cure him of that. The experience of being unable to "get hold of the concepts behind what was going on [was] so traumatizing that I developed a technophobia and dislike of anything rigorously scientific." After a year of looking around, he found that geology and earth sciences intrigued him.

After a summer of UROP research trying to model shallow ocean bed conditions, he took his first semester of all-music courses "and I loved it. There were some fine musicians, and the faculty was very strong and very, very encouraging. . . . The faculty will bend over backward for undergraduate students. . . . I took John Harbison's twentieth-century music history course, which was an eye-opener for me. I became an ardent fan of Bartok, was exposed to the Viennese School for the first time, and to Aaron Copland. At the same time I began composing my first atonal music."

Some of Julio's music concentrates on funneling the exuberance of his outer persona. *Animals*, for example, a song by the group Talking Heads he arranged for the Logarithms, is brilliantly comic as well as musically full of intrigue. But the best clowns also dream, and Julio likes to reflect as he laughs and find light in the deepest of pathos. His *Four Dream Songs*, composed as his senior thesis and the highlight of his Killian Hall recital, are witty, touching, and rich from both a dramatic and a musical viewpoint.

Julio got the idea for *Dream Songs* in his sophomore year. He encountered John Berryman's 77 *Dream Songs* while taking a poetry class and was overwhelmed by them, "by their humor, by the potency of their ideas." Peter Child, who teaches the

advanced composition seminar, "struck it off very well" with Julio, and encouraged him to set four of the songs to music. A happy relationship ensued. Julio said Child proved to be "very insightful and very helpful. He's never condescending and he's never pushy. And he simply has a wealth of sources to go to and ideas for a student." Child for his part found Julio to be "very musical, very inventive."

*With a
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Julio sees "theater as a way to work out emotional issues, and music as a way to work out issues on another level, one more intellectual and more spiritual, more mystical." Vocal settings, lying at the intersection of drama and music, present Julio with the opportunity of combining the special elements of both, and especially of humanizing twentieth-century music, much of which he finds to be too dissonant and disconnected from life.

An especially strong characteristic of *Four Dream Songs* is Julio's success in forming a vibrant, harmonious set of relationships between the texts and the music, each of which seems to grow organically out of the other. "All of the music is genetically linked to the text; they have the same genesis," Julio says.

John Harbison, Pulitzer Prize-winning composer and Class of '49 Professor of Music, credits "the dramatic flair of his actor's training" in the M.I.T. Shakespeare Ensemble with enlivening Julio's composition. In *Four Dream Songs*, the music not only builds upon the drama in the texts, but the violin and piano that accompany the baritone voice are themselves highly

anthropomorphic actors in the drama. As Julio commented, "The piano line was set as a counterpoint, counter idea to the voice, [the] violin set to be an adjacent voice—it was thinking the same things. The violin was a real character. All of them were jokers."

Julio's settings showed a fresh originality; but though his composition was not tied to the texts in obvious ways, the voice seemed to rise naturally from the music. His understanding of both the content and the rhythm of words was apparent throughout, and ensured that those words-as-songs meant more than ever they could as words alone.

The final lines are the most complex musically, and full of psychological insight. "Nobody is ever missing" come the last words and notes. The listener is left locked in the aftermath of what Julio sees as his work's Chekovian tragedy: "I guess you don't realize how serious things are until the very end . . . suddenly you're aware of the world underneath the texts, and the sorrow."

The May 11 recital also included a piano prelude, two pieces for flute and piano, two Hebrew hymns, and even a jazz arrangement, all Friedman compositions. Only the Hebrew hymns failed to work, and Julio admits that in their cases "I transgressed entirely; I didn't understand or work with the Jewish texts. . . . I am going to have to get more in touch with Judaism before I can break ground with . . . Hebrew choral settings."

Julio is performing with and has composed music for Ulysses Productions, a group of M.I.T. alumni who rented the Alley Theatre in Cambridge last summer. But he's also looking for a 9-to-5 job in hydrology "until I can absolve my debt, and I'm perfectly content with that. After all, C.P.E. Bach studied law for two years."

Peter Child nonetheless says Julio has the potential to be a successful professional composer. And, even as he searches for his science-based job, his mind is fertile with ideas for the songs, theater music, and opera that he says he wants to compose in the near future. We can expect Julio to be a noted contributor of profound musical accounts of the human experience in the years to come. And, by the way, he did pass 8.012—"Physics for Masochists." □

not have an apartment. If you'd like to contact him, I do have an alternate address for him.

Please write regarding the reunion and any new gossip.—**Diane M. Peterson**, President, 350 Palos Verdes Blvd., Apt. 20, Redondo Beach, CA 90277-6329

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Let's start off with the weddings! **Douglas Weems** married his high school sweetheart on February 7, 1987, five days after completing his master's in aero/astro. He is now working as a structures engineer for Boeing Helicopters in the Philadelphia area. . . . **Mike Phillips** is now married to Betsy Campbell of Virginia Beach. They live in Dayton, Ohio, where Mike is stationed at Wright-Patterson AFB. . . . **Margaret Hirlinger** married Scott Douglass, '84, on August 3, 1985. Their son, Alan James, was born October 20, 1987. Could he be the first progeny of the class of '85? Margaret is now taking a year off from Stanford's Ph.D. program. . . . **Carl Pietrzak** married Irina Rakin, '86, on June 27, 1987. He is having fun working as an electrical engineer at Motorola. Carl has been awarded three patents and has published a paper. Irina is working as a mechanical engineer for Amoco. She earned her master's from University of Michigan last year. They both love being in the Chicago area. Carl claims that **Dave Todd** has been throwing some great parties. Dave is doing well as a physics Ph.D. candidate University of Chicago.

Robert Robinson recently completed the "Seabee" Chief Petty Officer Management Course at the Naval School for Civil Engineer Corps Officers in Port Hueneme, Calif. He was trained for duty as a first-level manager in the Naval Construction Force. . . . **Maurice Barrant** is stationed at Tyndall AFB, Fla., in the Weapon Systems Evaluation Program.

Some very welcome news is that after two years of political imprisonment **Ramanujam Manikkalingam** has been freed. The Sri Lankan government had accused him of being a member of a revolutionary group. He was released under the terms of a peace accord designed to end the civil war there. He is reported to be thin but in good health, and he still has his sense of humor!

Robert Balcius is completing his M.S. thesis at the University of New Hampshire specializing in polymer kinetics. Since he has been in New Hampshire, he has become the individual development vice-president of the Greater Derry Jaycees and the captain and founding member of a revolutionary war light infantry reenactment group. . . . **William Meeks** received his master's degree in computer science from Brown last May. . . . After working two years in management consulting for Booz Allen & Hamilton in Brazil, **Roberto Engels** enrolled in the graduate school of business at Harvard.

John Ragan is in his fourth year of grad school in the chemistry department at Yale. He is sharing an apartment with **Bob Rosenberg**, who's in the same department. John sees **Ron Van Veen** fairly frequently during his trips from Philadelphia to Boston. He also saw **Jay Elson** in Boston last March. Jay was married this summer and is working in Los Alamos, N.M. . . . **Alan Shapiro** is in his fourth year of an M.D./Ph.D. program at the University of California in San Francisco. He finds graduate school to be a welcome change of pace from his medical studies.

Michael Cassidy is the chief strategist for GM's *Sunracer*, the solar-powered car that won the 3,000-kilometer race across Australia last November. He is living in Manhattan Beach, Calif. . . . **Alec Atkin** was living nearby in Newport Beach studying Japanese for two years. He has put it to good use since he has been working outside of Osaka since June and plans to stay for two years. He packed his wetsuit so he would be prepared for some gnarly surfing and decent diving.

Jeann Moroney is still working at Adaptive Optics Associates in Cambridge, Mass. She enjoys it

immensely! Valentine making sprees continue annually at her apartment, though no longer as an IAP activity. . . . **Richard Corkran** is working as a corporate pilot for Du Pont, based in Wilmington, Del. . . . **Jose Cordeiro** writes that Schlumberger oil exploration business sent him to Mexico for two years, France for six months, and now Angola. Another M.I.T. graduate was in Angola before him, George Dvorak. And Mia Piaget was in Paris before him. What next?—**Stephanie Winner**, Secretary, 1026 Live Oak Dr., Santa Clara, CA 95051

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James Person writes from the Persian Gulf. Both he and **Chris Medina** are naval officers on the U.S.S. *Merrill*. James says that nothing at M.I.T. prepared them for dodging missiles, maneuvering around mines, warning off hostile aircraft, or firing on enemy command posts (and getting fired back upon!). Both James and Chris will return to San Diego in late summer. James bought a condo with Jon Athow, '87, who is also out in the Persian Gulf aboard the U.S.S. *Reasoner*. James, at one of his port calls to Seychelles, talked to **Suzanne Danbar**, who is in Belgium. She was considering a trip to the beaches, but her mother was visiting. James also talked to **Dennis Arnow**. Dennis, who works for Booz Allen & Hamilton, is considering a career move.

Man-Cheung Max Lui is finishing up his master's thesis at Draper Lab in May. A trip to Europe is planned over the summer. He was also naturalized as a U.S. citizen on November 19, 1987. Congratulations! . . . **Tom Shea** writes in that he is from the government and is here to help. We can only wonder. . . . **Jeremy Verba** is living and working in New York City. He says Wall Street is a far cry from architecture, but he's having fun.

David Cultice spent the past year and a-half with Cryovac in South Carolina designing and developing food packaging machinery. He is enjoying the Piedmont climate. . . . **John Martin** is finishing up his second year with Oracle, where he works as a consultant. He recently moved to Denver to "advance a relationship". . . . **Jonathan Wyss** began a 16,000-mile journey in June 1988 that will take him from the Canadian Arctic to the southern tip of the Americas. He will use no motorized transport. Instead, he will bicycle, kayak, ski, walk, and sail. Jonathan expects it will take him about three years to complete.

Tom McKendree writes in from Garden Grove, Calif. He attended the East Campus annual steer roast, where he ran into a few of his old "gang". **Linda Robeck** is now working for JPL. . . . and **Walter Santarelli** came back from Seattle where he works for Boeing. **Ed Humphrey** lives in the Boston area; **Jay Adams** flew out from Ft. Collins, Colo., where he works for HP; and **Geoff Englestein** came up from New Jersey, where he works for his father's product sub-contracting firm. And, **Carlos Montero** was asked by his company in Spain to fill in at a symposium in Boston, so Carlos made it to the steer roast. Quite a homecoming!

Carolyn Beer sent me a postcard from the island of Great Exuma, which is one of the "Out Islands" of the Bahamas. Gee, the only thing to do all day was sailing, snorkeling, or scootering around the 32-square-mile island. Life is hard! . . . **Noel Zamot** and **Ellen Epstein** came out to Los Angeles to visit. Noel is finishing up his navigator training at Kastle AFB, and Ellen was out on business with Merrill Lynch. Ellen says that **Karen Wohl** will start Harvard Business School this fall. . . . Also, **Anthony Scotti** recently moved into an apartment in Boston with several '87 grads from Baker House.

I discovered that I play volleyball on Hermosa Beach with the older brother of Phyllis Krystle, '87, another Bakerite. Small world. . . . **Marilyn Oberhardt** spent a week in Florence, Italy, on official air force business. Unfortunately, I didn't

get on the program early enough to make this trip, but we're both looking forward to Capri next year. Munich was great. Please write.—**Mary E. Cox**, Secretary, SD/CLTP P.O. Box 92960, Los Angeles AFB, CA 90009-2960

87

Eric Shih is now a grad student in mechanical engineering at M.I.T. and is working in the computer-aided design laboratory. He is married to **Katy McCollough**, a software engineer at Foxboro Co., and they are living in their new condo in North Attleboro with two horses.

Eric gave me some information about other classmates. **Stuart Simon** is working at Raytheon after finishing up his co-op there. . . . **Steve Beringhouse** finished his master's in mechanical engineering and is working at the biomechanics lab at M.I.T. . . . **Bill Lai** is working for General Dynamics in San Diego. . . . **Scott Bryant** finished his studies in aero/astro and left M.I.T. to work at Rockwell.

Peter Scully writes that he is living in Hoboken, N.J., and is working for Merrill Lynch & Co. as a financial analyst in the Public Finance Group in Manhattan. He plans to apply to business school in the fall—his first choices are M.I.T. and Harvard. . . . **Elmer H. Lyons** is living in Cambridge and attending graduate school in electrical engineering and computer science. . . . **Christopher Linn** is leaving the M.I.T. Office of Admissions and moving to San Francisco to work at a software firm. . . . **David Shupe** has completed his first year of graduate study in physics at Cornell University and has recently been awarded an NSF graduate fellowship. . . . **Carol Webb** married Bill Mohr, '84, last April in Belmont, Mass. Congratulations!

Vivian Leung is one of four nationally selected for a nuclear waste management fellowship in the Nuclear Engineering Department at M.I.T. . . . **John Sadlier** is employed in the aeronautics field. He is also a moderator for the decathlon team of Our Lady of Providence High School in Rhode Island.

Jim Linn finished his first year at Pritzker School of Medicine (University of Chicago) and is doing research with an ophthalmology professor on an NIH student stipend. Two other '87 grads are in Jim's med school class: **Bob Litt** is an M.D./Ph.D. student, and **Ed Whang** is a regular med student.

Louis Kuchnir, **Rachel Lum**, **Matt Healy**, and **Patti Lodi** will all be starting their second year in the Department of Chemistry at Harvard this fall. There are a lot of Techies (not to be confused with Caltech techers, of which there are also quite a few) at Harvard Chem—we plan to infiltrate and conquer! Even **Mark Mastandrea** was sighted in the chem labs there, although he is at Berkeley now. Patti ran into **Andy Joe** at Tosci's; he'll be starting his second year in med school at Albany this fall.

Eli Niewood is still hanging out at the Tute in Course XVI grad school. . . . **Joyce Licini** is enjoying the work at Lotus Corp. in Cambridge. . . . **Dan Saal** is going to be a student until at least 1995, since he's in the M.D./Ph.D. program at Yale. . . . **Laura Kotovsky** is at University of Illinois studying cognitive science, and **David Brown** is working at ESL Corp. in or near Silicon Valley.

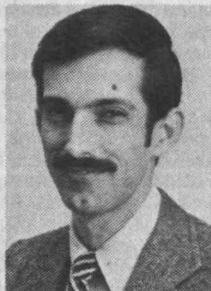
I have to let you all know about my change of address. I'm moving to Cambridge and will be living with **Lowell Kim** (Cambridge Institute for Information Systems), **Dan Kennedy** (Oracle in Boston), **Anthony Scott** (Mutual Bank of Boston), and **Janet Zharadnik** (grad student in mechanical engineering at M.I.T.). I'll be starting the master's program at the Kennedy School of Government at Harvard to study public policy and city planning. Please write! I need your help to make these columns as informative as possible. My new address is: **Stephanie Levin**, 41 Prentiss St., Cambridge, MA 02138



COURSE NEWS



H. J. Parmelee



G. J. Vicens

I CIVIL ENGINEERING

Paul Roberts, S.M.'57, is currently president of Roberts Associates, a transportation consulting firm located in Washington, D.C. . . . **Michael D. Meyer**, Ph.D.'78, has been serving as Director of the Bureau of Transportation for the Commonwealth of Massachusetts, responsible for state and regional transportation planning, project development, environmental assessment, and traffic engineering. In September he became professor of civil engineering at Georgia Tech. . . . **Lloyd A. McCoomb**, S.M.'70, was recently appointed director general of airport marketing for the Airport Authorities Group of Transport Canada, located in Ottawa. . . . **Richard M. Dillon**, S.M.'50, was appointed member of the Science Council of Canada in May of 1987.

Chi Epsilon, the National Civil Engineering Honor Society, announced that **Arthur N.L. Chiu**, S.M.'53, professor of civil engineering at the University of Hawaii at Manoa, was re-elected national president of Chi Epsilon. His term runs until April, 1990. . . . **Harold J. Parmelee**, '60, was unanimously elected to become president of Turner Construction Company. Previously he was executive vice-president and COO. The Turner Corporation is the nation's largest general building contractor.

Frank J. Heger, Sc.D.'62, was awarded the American Concrete Pipe Association's Award of Special Merit, recognizing his many years of research in concrete pipe. Heger founded Simpson Gumpertz & Heger, Inc., of which he is now principal, and over the years has been responsible for the design of such landmark dome structures as the 250-foot-diameter geodesic dome of the U.S. Pavilion at Montreal's Expo '67 and the 160-foot-diameter dome of the Spaceship Earth theme pavilion at Epcot Center in Florida.

From Mexico: **Francisco A. Garcia-Ranz**, S.M.'85, is a research engineer at the Instituto de Investigaciones Electricas working on the dynamic response of industrial concrete chimneys. . . . **Daniel Lieberman**, S.M.'84, writes to say that he has founded Hologramas de Mexico, a company that manufactures the embossed and dichromated holograms used in credit cards, labels, and stickers.

Michel H. Zaleski, S.M.'71, is chairman of Zaleski Sherwood and Co., which organizes and invests in corporate recapitalizations. . . . **Ronald G. Rice**, S.M.'64, is associate professor in the School of Urban Planning and in the Department of Civil Engineering at McGill University in Montreal. . . . Bangor and Aroostook Railroad has announced the appointment of **David M. Kruschwitz**, S.M.'78, as assistant vice-president for transportation. . . . **Jorge E. Arana**, S.M.'44, is living in Bethesda, Md., after retiring in March 1987 from W.R. Grace and Co. During his 35 years as plant construction project engineer and manager, Arana worked in Brazil, Mexico, Indonesia, France, the U.S., and five other countries.

Goldberg Zoino & Associates of Newton Upper Falls, Mass., recently announced two promotions: **Matthew J. Barvenik**, S.M.'77, to senior consultant for both the geotechnical engineering and the environmental services divisions in the Newton office; and **Kevin J. O'Reilly**, S.M.'80, to associate and operational manager of the environmental group at the Vernon, Conn., office.

Guillermo J. Vicens, Ph.D.'74, was recently elected senior vice-president of Camp Dresser & McKee Inc. of Boston. Vicens is the manager of the environmental planning and management unit of CDM in New England, specializing in computer modeling of environmental problems, especially in CDM's involvement in the clean-up of the Boston and New Bedford harbors. . . . **Stuart D. Werner**, Civ. E.'65, an earthquake engineering and soil and structural dynamics specialist, has joined Dames and Moore in their San Francisco office. Werner is presently investigating seismic analysis of bridge design in southern California.

Antonio A. Gonzalez-Quevedo, S.M.'77, is an assistant professor in the general engineering department at the University of Puerto Rico at Mayaguez. . . . **Alonso E. Rhenals**, Civ. E.'75, is working for the Analytic Sciences Corp. of Reading, Mass., in the physical sciences division. Most recently, he was promoted to department staff analyst, "for his original contributions in algorithm design and development, geodesy, and hydrology."

II MECHANICAL ENGINEERING

Larry M. Sweet, Ph.D.'74, has been appointed manager of machine tool marketing and sales for GE Fanuc Automation North America, Inc. Previously, Sweet was located at the GE Corporate R&D Center in Schenectady, N.Y., where he was manager of the artificial intelligence branch.

The American Society of Mechanical Engineers (ASME) recently announced that **Bharat S. Shiralkar**, Sc.D.'69, has been named a Fellow of ASME. Shiralkar is manager of safety and thermal hydraulic methods at GE Nuclear Energy in San Jose, Calif. . . . **Kwon Hee Kim**, Ph.D.'87, is a postdoctoral research fellow at the University of Michigan in Ann Arbor. He is doing experiments on the anisotropy of engineering sheet metals and work in the modeling of damage mechan-



S. D. Werner



L. M. Sweet

isms in superconducting ceramics. . . .

Christopher S. Weaver, S.M.'85, has started a software company called Bethesda Softworks. . . .

Peter Kalustian, S.M.'34, reports that he is still very active in his work in the technology of food fats and oils. He recently returned from Australia and Italy on a busy schedule and he predicts that this pace will continue, while lamenting the fact that he had to cut his downhill skiing down to 52 days last winter. However, he was planning to ski in Bariloche, Argentina, in August, and is looking forward to his 55th reunion.

Michael Dubey, S.M.'48, has been retired from Lockheed since 1982. He has been lecturing and consulting around the world in systems engineering management, after he sold his share in an energy-saving air conditioning invention that he helped to develop and market. Last but not least, he reports that he is a grandfather—twice.

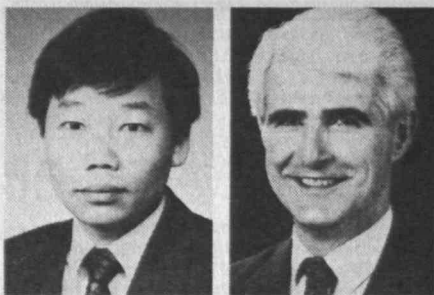
"Retired, still having fun," writes **Sidney A. Whitt**, S.M.'37, from Bozeman, Mont. "Wife Milli-cent (Smith '32) and I live 80 miles north of Yellowstone Park and would welcome G'34 mechanical engineering classmates to 'Chef Whitt's meal of antelope or venison.'" His eldest son, Greg, is a professor of genetics at the University of Illinois, and Whitt apologizes that his next-eldest, Ward, received his Ph.D. from Cornell instead of M.I.T. His address is 1004 S. Willson Ave., Bozeman, MT 59715.

Frank Tai, S.M.'80, writes: "After spending three years working for the aerospace conglomerate, TRW, I went to work for a small consulting firm called Microcosm. I will be exploring the managerial, marketing, and technical aspects of this firm, which specializes in space mission engineering and satellite altitude control. Also, am getting married in May of 1988." Congratulations, Frank.

Jeung T. Kim, Ph.D.'87, has recently joined the GE R&D Center as a mechanical engineer. Previously he was a consultant engineer for the Kirk Meyer Co. in Long Island, N.Y.

III MATERIALS SCIENCE AND ENGINEERING

William H. Rhodes, Sc.D.'65 has been elected president of the American Ceramic Society. Rhodes is a senior staff scientist at GTE Labs in



J. T. Kim

W. H. Rhodes

Waltham, Mass., and a well-recognized ceramist. . . . Reinhart, Boerner, Van Deuren, Norris & Rieselbach announced that **Michael D. Rehtin**, Ph.D.'70, has joined their firm. Rehtin will be the managing shareholder of the intellectual property department.

Rep. Don Ritter (R-Penn.), Sc.D.'66, is one of the most outspoken critics in Congress of the proposed superconducting supercollider, for which a building site has not yet been selected. SSC advocates argue that it will provide research opportunities to young scientists, push research in the field of superconductivity, help scientists increase their understanding of the universe, and lead to applications that benefit astronomy, the local economy, and American scientific efforts on the whole. Ritter disagrees. "A project devoted to investigating sub-atomic particles is an incredibly perverse and expensive way to make America more competitive," he says.

IV ARCHITECTURE

Prataap Patrose, S.M.'84, is senior urban designer and planner of the Boston Redevelopment Authority's Urban Design Department. Patrose co-produced the major outdoor art and architectural installations for Boston's First Night Celebration in 1987 and will be doing the same in 1989. His current interests include gardening, travel, photography, and carving decoy ducks.

Doru Iliesiu, S.M.'83, in collaboration with colleague John Kanastab, received second prize in the 1987 New York Waterfront Competition for their development proposal for a 4.5 mile strip of Hudson River front. Competition advisor was M.I.T. Professor **Gary A. Hack**, Ph.D.'76.

Nicholas Harris, M.Arch.'82 is the project manager for a \$42 million office building being built for American Savings and Loan in Stockton, Calif. . . . **Joseph C. Migani**, M.Arch.A.A.'79, is a principal of O'Riordan Migani Architects, a multidisciplinary, fully computerized firm located in Derby, Conn.

From Mexico, **Francisco Cardenas-Munguia**, M.Arch.A.A.'77, writes that he is a private designer, chief of Plura, S.C., and president of Pro-Ecologia de Colima, a non-governmental organization supporting environmental protection.

V CHEMISTRY

Northern Illinois University recently announced that **James E. Erman**, Ph.D.'66, was designated as an N.I.U. Presidential Research Professor. This professorship will allow Erman to continue research work over a four-year period with an award of \$5,000 per year and a release from teaching and service duties equivalent to one semester. Erman's research has focused on the heme proteins, which contain iron and perform a variety of functions in living cells, including Erman's particular interest, the transfer of electrons.

Kenneth B. Wiberg, '48, Whitehead Professor of

Chemistry at Yale University, is the 1988 recipient of the American Chemical Society's Arthur C. Cope Award, which consists of a \$15,000 prize and a \$25,000 grant-in-aid to the university of Wiberg's choice. Wiberg does research on chemical bonding in organic systems and its consequences. He holds a number of other awards for outstanding work in organic chemistry.

Honored in Schenectady, N.Y.: **Dwain M. White**, Ph.D.'57, received a Coolidge Fellowship Award from the GE R&D Center. Cited were his contributions to the understanding of polymers, which has led to the development of high-performance plastics for use in appliances and automobiles. White joined GE in 1956 and lives in Schenectady with his wife, Kathleen.

Deceased, with no further information available: **Orville L. Mageli**, Ph.D.'53, in November 1987. Also, **Charles M. Apt**, Ph.D.'52, died April 8, 1988, after a long career with Arthur D. Little and a long residency in Belmont, Mass. Apt worked for Arthur D. Little from 1954-1963 in the food and flavor sections, and from 1969 to his death was manager of the food and agribusiness section and later a vice-president; in the interim he was associate director of the Exploratory Development Laboratory at United-Carr in Cambridge.

James D. Bentsen, Ph.D.'86, was granted a \$63,000 postdoctoral fellowship by the American Cancer Society to study a chemotherapeutic agent that inhibits the rapid growth of DNA. This agent could potentially become a treatment for AIDS and cancer. Bentsen is an M.I.T. researcher. . . .

Also at M.I.T.: Professor **Mark S. Wrighton**, head of the chemistry department, was named the 1988 recipient of the American Chemical Society Award in Inorganic Chemistry. He has gained a wide reputation for his work in photochemistry and other inorganic fields and became department head in July 1987. Last April, Wrighton was pleased to announce the establishment of the George H. Buchi Visiting Lectureship in honor of M.I.T. professor **George H. Buchi**, who has taught in the Department of Chemistry since 1951 and became the department's Camille Dreyfus Professor of Chemistry in 1971. Buchi has been commended by the American Chemical Society, the University of Heidelberg, and the government of Japan, among others, for his work in photochemistry, toxicology, total synthesis of complex natural products, and odor chemistry.

Helix Technology Corporation honored **Howard O. McMahon**, Ph.D.'41, by establishing a research endowment fund for the study of physical chemistry in the Department of Chemistry at M.I.T. McMahon was a pioneer in the field of cryogenics and "today, over 70 percent of the revenues of Helix are derived from equipment . . . bearing his name as co-inventor." He has also been a member of the board of directors of Helix since its founding in 1967.

Alan E. Walts, Ph.D.'85, writes that he was "recently appointed director of synthetic and biological chemistry at Genzyme Corporation, a Boston-based biotechnology company."

"Standing Faithfully in Creation: Where Faith and Environmentalism Meet" was a forum held last April in Williamstown, Mass., at which **William R. Moomaw**, Ph.D.'65, spoke. Moomaw is the Ebenezer Fitch professor of chemistry and environmental studies at Williams College.

Richard A. Durst, Ph.D.'63, wrote to make a correction in the July 1988 issue. Corrected: Durst was named Chairman of the first Gordon Research Conference on Bioanalytical Sensors and elected to the board of directors of the Society for Electroanalytical Chemistry.

VI ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Alan V. Oppenheim, Sc.D.'64, professor of electrical engineering and computer science at M.I.T., has been selected to receive the 1988 Institute of Electrical and Electronics Engineers Education



J. E. Erman

A. Goldstein

Medal "for his leadership in engineering education through teaching, textbooks, and videotape lecture series in digital signal processing."

The IEEE also conferred fellow grade on several M.I.T. alumni: **Thomas P. Barnwell, III**, Ph.D.'70; **John P. Burg**, S.M.'60 (Course VIII); **Talbot S. Huff, Jr.**, '62; **Jeffrey M. Jaffe**, Ph.D.'79; **David Leeson**, S.M.'59; **Martin D. Levine**, S.M.'34; **Kenneth M. Mitzner**, '58; **Hughes St-Onge**, Ph.D.'71; **John W. Woods**, Ph.D.'70.

John M. Cochran, S.M.'64, former president of Cochran Associates, has joined Texfi Industries in Rocky Mount, N.C., as vice-president and technology manager. . . . **Kenneth R. Allen**, S.M.'72, is a partner in the firm of Townsend and Townsend, specializing in patents, trademarks, and copyrights in Palo Alto, Calif.

Sidney E. Caldwell, '32, died in February 1988. He was living in Portland, Ore. Also, word has arrived of the death of **Maurice J. Perouse**, S.M.'37, in September 1985. He was living in Paris. His widow writes that Perouse held a deep attachment to the United States since his years at M.I.T. and renewed it during his term as a financial attaché from 1952 to 1957. "He traveled there almost every year since then for meetings with monetary funds and kept close ties of friendship with Americans. Since 1982, as a consultant for Goldman Sachs, he went to New York four times a year."

Raytheon has honored **Robert A. Pucel**, Sc.D.'55, with an Excellence in Technology Award. Pucel, a member of Raytheon's research division in Lexington, Mass., received the award for pioneering the concept and technology of printing microwave circuits on tiny gallium arsenide chips for use in military radar and cable television. . . .

Todd L. Rachel, S.M.'66, was named vice-president of technology and quality of TRW Vehicle Safety Systems of Washington, Mich.

Herbert H. Woodson, Sc.D.'56, acting dean of the College of Engineering at the University of Texas at Austin, has been named the Outstanding Engineer of the Year by the Texas Society of Professional Engineers. He has been on the UT Austin faculty since 1971 and was appointed acting dean in 1987.

An honorary Doctor of Humane Letters from Pine Manor College was awarded at its commencement in May to **Marvin Minsky**, co-founder of the M.I.T. Artificial Intelligence Project and Donner Professor of Science in the Department of EECs.

Sidney Sklar, S.M.'60, was promoted to program manager of the information systems staff at Draper Lab. . . . **Robert Price**, Sc.D.'53, writes: "I have joined the research division of the Raytheon Company, Lexington, Mass., where I am engaged in telecommunications, radar, sonar, and signal processing."

Surendra Amerasinghe, Elec.E.'74, is EDP director/consultant at People's Bank head office in Colombo, Sri Lanka, overseeing a computer installation project. The project involves a main-frame computer, 40 branch automation systems, and 265 semi-automation systems.

Robert Habich, S.M.'43, of Rheinfelden, Switzerland, died February 21, 1988. No further information is available.

Centennial Gala for Course III

Visiting Committee Chairman Robert Mitchell, S.M.'47, offered a toast to "one of, if not the outstanding department in the world," thereby kicking off the Materials Science and Engineering (MSE) Centennial Banquet on June 1. More than 350 people attended the event, which was held at the Boston Museum of Science.

Participants first enjoyed a private showing of the museum's "Ramesses the Great" Exhibit, which has broken museum attendance records in several American cities. Following dinner and cocktails, greetings were offered by distinguished alumni from widely separated parts of the globe: Tasuku Fuwa, Sc.D.'58, of Japan; Rolf Nordheim, Sc.D.'53, of Norway; and Ronald Kurtz, '54, of the United States.



ABOVE: George Kenney, '74 (Sc.D.'79), assistant director of the Materials Processing Center, holding up the banner sent by Chester Shih that marks the worldwide contributions of M.I.T.'s graduates in Materials Science and Engineering. Shih is vice-president of the Chinese Academy of Science and is also a former visiting researcher at M.I.T.

The MSE Department, according to Nordheim, "has played a major role in the development of the United States today. But its influence has gone far beyond national boundaries to most countries in the world."

Students and faculty entertained banquet-goers for the rest of the evening. Doctoral candidate Jacqueline Isaacs, S.M.'86, chair of the Graduate Materials Society, explained the theme developed by students for the department's anniversary. She showed a schematic illustration of a structural defect in materials known as "edge dislocation." Thus, the slogan that appeared on commemorative T-shirts and coffee mugs: "100 Years at the Edge."

Professor Emeritus Cyril Smith, '26, arguably the oldest alumnus attending, received an award from the Museum of Science for his help on the Ramesses exhibit. Smith wrote a chapter of the Ramesses catalog. "His ideas about how art, science, and technology are tied together were used in setting up the exhibit," said exhibit planner Cynthia Mark-Hummel.

Professor Harry Gatos, Ph.D.'50, performed a flute solo; Professor Ronald Latnison showed slides of the department's history; and graduate student Brian Leibowitz, '82, discussed Institute hacks from 1876 to 1988. Remarks by department head Merton Flemings, '51, and Dean of Engineering Gerald Wilson, '61, concluded the evening.

Flemings announced that the department had received more than \$4 million in centennial gifts, including the establishment of the Morris Cohen and POSCO Professorships. Flemings read excerpts from telegrams and letters of congratulations received from alumni throughout the world, including a letter from the M.I.T. Club of Turkey, which celebrated the centennial with a banquet in Istanbul. —Steve Nadis □



B. Tarter



S. A. Jackson

of LLNL in 1967, was named division leader in 1978, and deputy associate director for physics in 1984. He has made significant contributions to LLNL's weapons and fusion programs, conducted theoretical studies in astrophysics, and helped organize LLNL's program to understand the global climate effects of nuclear war.

Dale D. Koelling, Ph.D.'68, has been promoted to senior physicist in the Materials Science Division at the U.S. Department of Energy's Argonne National Laboratory in Argonne, Ill. . . . Fulvio Melia, Ph.D.'85, joined Northwestern University as an assistant professor in the department of physics and astronomy in 1987 and was most recently named one of 148 Presidential Young Investigators by the National Science Foundation. Melia, a theoretical astrophysicist, received the award and accompanying grant for his "potential for research and teaching." The awards are intended to overcome growing faculty shortages in highly competitive fields of science and engineering.

Gisela Hartel, Ph.D.'86, a manager with Pacific Telesis International and a German citizen, wrote an article that appeared in the PacTel newsletter about her experiences during the astronaut selection program in Germany. In 1985, Hartel endured an exhaustive battery of physiological and psychological tests over a period of days. She was also evaluated on subjective criteria like "media acceptability" and "political adaptability." Hartel was ultimately accepted into the astronaut program but turned it down, being reluctant to commit herself for 10 years when she realized that she might never fly in space. However, she writes that she will remain in the stand-by pool, just in case.

Shirley A. Jackson, Ph.D.'73, was recently honored by the Executive Women of New Jersey at their awards dinner in April, 1988, in Teaneck, N.J. Jackson is a physicist at the Scattering and Low Energy Physics Research Department at Bell Laboratories in Murray Hill, N.J., and serves on the board of directors of New Jersey Resources Corporation and Public Service Enterprise Group, Inc.

IX PSYCHOLOGY

The only Course IX news: Clark University psychology professor Marianne Wiser, Ph.D.'81, has been awarded a two-year grant totaling \$247,619 from the James S. McDonnell Foundation. Wiser, in collaboration with UMass/Boston psychology professor Carol Smith and M.I.T. Professor of Cognitive and Brain Sciences Susan Carey, will study how students' understanding of scientific concepts change during the middle school years. They will observe and test students in grades 6-8 in Massachusetts public schools. Findings from the research, part of a \$4.1 million project called "Cognitive Studies for Educational Practice," will be used to design computer-based curricula to teach scientific concepts such as heat vs. temperature, weight vs. density, and the atomic theory of matter.

VII BIOLOGY

David Baltimore, '61, professor of biology at M.I.T. and director of the Whitehead Institute for Biomedical Research, was recently elected to the Institute of Medicine.

The American Cancer Society granted Robert A. Weinberg, '64, M.I.T. professor of biology and member of the Whitehead Institute, \$200,000 to study oncogenes. His research on the gene that causes retinoblastoma, an eye tumor prevalent in young children, will shed light on other genes that stimulate the growth of cancer.

Judith L. Lucas, S.M.'52, of Lexington, Mass., passed away September 17, 1987.

VIII PHYSICS

Hutzel Hospital in Detroit, Mich., announced that Albert Goldstein, Ph.D.'65, will be honored at the Historical Symposium on Medical Ultrasound in Washington, D.C., in October 1988. Goldstein is being recognized as the developer of the first modern ultrasound imaging equipment (the digital scan converter); image quality assurance test objects and testing procedures; and as a lecturer on the physics of ultrasound imaging.

Lawrence Livermore National Laboratory in Livermore, Calif., named C. Bruce Tarter, '61, as associate director for physics. Tarter joined the staff

X CHEMICAL ENGINEERING

Ralph M. Gifford, S.M.'58, a manager-engineer at Pfizer Inc., New York City, died April 4, 1988, after a long illness. He is survived by his wife, Judith, two sons, Scott and Kenneth, and a daughter, Leslie.

Michael J. Kell, S.M.'72, writes that he is founder and president of "a private outpatient drug treatment center in Atlanta, Ga., specializing in opiate and stimulant abuse."

Deceased: **William J. Sweeney**, Sc.D.'28, of North Andover, Mass., died March 30, 1988. He was a research director at Standard Oil Co. of New Jersey (Exxon) and is survived by his wife, Louise, and three sons. . . . **Richard Nelson Palmer**, S.M.'28, died May 16, 1988. He was living in Wolfeboro, N.H., and leaves his wife, Eunice.

. . . **William G. Williamson Jr.**, S.M.'40, of Lexington, Va., died on March 5, 1988. . . . **Robert W. Dickinson**, S.M.'53, of Altadena, Calif., died September 8, 1985. He leaves his wife, Marjorie.

. . . **Edwin L. Howard**, S.M.'38, died March 19, 1988. He was living in Winters, Calif. . . . **Preston S. Shane**, S.M.'46, died November 10, 1987. He was living in Easton, Md.

Edwin H. McCormick, S.M.'32, retired in October of 1985 from his position as superintendent of the Water and Wastewater Departments of Jekyll Island, Ga. He writes that the plant, a combination of trickle filter and activated sludge processes, won state and national recognition for excellence of operation. . . . The U.S. Department of Energy announced that **Adel F. Sarofim**, Sc.D.'62, has been awarded a grant from the University Coal Research Program. He will receive \$199,987 to undertake the "Mechanistic and Kinetic Studies of High-Temperature Coal Gas Desulfurization Sorbents" that he proposed earlier this year. Sarofim is a professor of chemical engineering at M.I.T.

Ty Robert Shockley, S.M.'86, received a Dissertation Fellowship from the Ford Foundation Doctoral Fellowship for Minorities Program. He will receive a one-year stipend.

XI URBAN STUDIES AND PLANNING

Niles O. Sutphin, M.C.P.'65, heads Sutphin Associates in Cambridge, Mass., which has recently completed the Davenport Building in Cambridge, King's Landing Condominiums in Swampscott, Mass., and the new Medico corporate head-



R. E. Speece



P. D. McKinnon

quarters in Lynn, Mass. . . . **James E. Wallace**, Ph.D.'72, is the technical director for the National Low Income Housing Preservation Commission. He submitted a report to Congress in April on the potential fate of 600,000 units of older subsidized housing and costs of preserving them for low-income households, and co-wrote a paper with Phil Clay on the same subject for the National Housing Policy Project.

Dean R. Johnson, M.C.P.'78, writes: "Returned recently from a three-year foray into the development of interactive video applications to full-time urban and environmental planning as a consultant and prospective developer of affordable housing. I hope M.I.T. will focus greater efforts on housing technologies to help meet the growing national housing crisis."

George W. Walsh III, S.M.'57, retired from the EPA in June after 31 years of service in air pollution control. . . . **Edward H. Kaplan**, Ph.D.'84, is assistant professor of operations research and public management at Yale, where he is studying mathematical models of the AIDS epidemic in order to evaluate proposed control/prevention strategies for the disease.

From Vanderbilt University: **George W. Malaney**, '57, is active in research in solid fermentations. . . .

Richard E. Speece, Ph.D.'61, professor of environmental engineering, was awarded the Outstanding Engineering Alumnus Award by Cleveland State University, where he received a bachelor of chemical engineering degree in 1956. Speece is recognized as an international authority in the field of water quality management and industrial waste management, and was recently named the Centennial professor of environmental engineering at Vanderbilt.

Citytrust has promoted **Elaine Savitsky Chapman**, M.C.P.'70, to the position of assistant vice-president and systems manager at the Trumbull Operations Center.

In his new book *Land Investment and the Predevelopment Process*, **Alan Rabinowitz**, Ph.D.'69, examines the strategic considerations of land investment for real estate investors at the predevelopment stage. "He investigates the impacts of economic conditions, federal programs, demographic and income-related trends, state and local policies, land use controls, and urban sprawl on the predevelopment process."

XII EARTH, ATMOSPHERIC AND PLANETARY SCIENCES

Douglas W. Dockery, S.M.'72, is assistant professor of environmental science and physiology at the Harvard School of Public Health. He is working on epidemiologic studies of the respiratory health effects of air pollution. On Patriots' Day in 1988, he played William Dawes in the annual recreation of the historic horseback ride of 1775, in which Dawes and Paul Revere warned patriots around Boston that British soldiers were marching northward.

Harold B. Hart, S.M.'52, is currently employed as a data processing analyst in the Information Services Planning and Admin. Dept. of Southern Company Services in Atlanta, Ga.

XIII OCEAN ENGINEERING

Guy Emmanuel, S.M.'79, recently completed a combined internal medicine and pediatric residency at King's County Hospital in Brooklyn and is now working for a community clinic in Orangeburg, S.C. . . . **Jeffery W. Hoyle**, S.M.'86, completed the Naval Basic Officer Course at the Naval Submarine School in Groton, Conn., in June. During the six-month course, he underwent instruction on the basic theory and operation of nuclear-powered and diesel submarines.

Capt. Wayne N. Fitzpatrick, Nav.E.'49, of Severna Park, Md., died December 4, 1987. . . . **Capt. Gerald G. Brown Jr.**, Nav.E.'52, of Potomac, Md., died November 14, 1987.

Jerry U. Shreter, S.M.'72, writes: "I have been living in Houston since 1978. Since 1982, I have been providing consulting and engineering services on marine terminals and dock facilities."

Retired Rear Admiral **W.W. Lisanby**, Nav.E.'56, says that since his retirement from the Navy he has founded and now serves as president and CEO of Naval Services International, a defense consulting firm based in Washington, D.C. He was also recently elected to the board of directors for United Services Life Insurance Company.

Sohail A. Faizi, S.M.'75, is working in Pakistan with Pakistan Petroleum Ltd., as deputy chief engineer on their SUI gas field compressor station.

. . . **Albert F. Suchy**, Oc.E.'80, is currently stationed at U.S. Coast Guard Headquarters in Washington, D.C. He is the ordnance section chief responsible for the maintenance of Navy-owned ordnance on Coast Guard cutters, and for the installation of the Harpoon missile system.

. . . **H.B. Ives** of New Haven, Conn., announced that **Richard F. Elliott**, S.M.'69, has been promoted to vice-president of operations. Elliott previously spent three years as vice-president of manufacturing.

XIV ECONOMICS

At the invitation of the Soviet Union's State Committee for Standards, **Armand V. Feigenbaum**, Ph.D.'51, spoke at the European Organization for Quality's 32nd annual conference held in Moscow in June. In his keynote address, he discussed the role of quality standards in Soviet Premier Mikhail Gorbachev's attempt to rebuild the Soviet economy. "Russian managers must ensure down through the ranks that positive working relationships and other incentives foster individual initiative, high morale, and the best possible job performance. . . . Quality is universal." He also spoke on the state of quality in the U.S., calling it "a moving target." Other countries are raising their quality levels, he said, so while the U.S. is improving quality of products and services, it has a long way to go to achieve quality leadership.

Ivy League news: **Whitney Newey**, Ph.D.'83, was one of the nine men who received tenure at Princeton University in the spring of 1988. A theoretical microeconomist with interests in econometrics, Newey joined the Department of Economics in 1983. . . . After two years as Provost of Yale, **William Nordhaus**, Ph.D.'67, returned to the Yale faculty last spring to do full-time economic research and teaching. . . . **Joseph F. Quinn**, Ph.D.'75, writes: "Good news: I just returned from a lovely semester's sabbatical at the University of New South Wales in Sydney, Australia. Bad news: I become chairman of the Economics Department at Boston College on July 1."

XV MANAGEMENT

Paul D. McKinnon, Ph.D.'82, was recently elected a principal of the management consulting and

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education firm Harbridge House, Inc., of Boston. . . . From Providence, R.I. **Lester H. Nathan**, S.M.'77, wrote to say that he has joined the American Insulated Wire Company in Pawtucket as an MRP II manufacturing analyst. . . . **John N. Maguire**, S.M.'60, was recently awarded the Peat Marwick High Tech Entrepreneur Award. Maguire is executive of the company he founded (with help from his wife and four children) in 1972: Software AG of North America, Inc., which went public in 1981, currently employs 470 people, and recorded annual revenues of \$67 million in 1987.

Purdue University announced that **Anantaram Balakrishnan**, Ph.D.'85, assistant professor of management, received the Krannert Master's Program Outstanding Teaching Award.

. . . **Arnold O. Putnam**, S.M.'47, of Mattapoisett, Mass., died on February 4, 1988. He was an executive officer for a number of management consulting firms in New York City; he retired in 1986 from Rath & Strong, another management consulting firm, after serving as president and CEO since 1967. He is survived by his wife, Dorothy, two sons, Timothy and Tyler, and a daughter, Pamela.

Steven M. Mendelsohn, S.M.'71, is currently principal and founding shareholder of Goss, Gilroy & Associates, Ltd. located in Ottawa, Canada, a management consulting firm specializing in public sector evaluation, policy studies, technology, surveys, and industrial development studies. . . . **Brian M. Monaghan**, S.M.'83, has moved back from Germany and is living in Toronto with his wife and two children.

Friends Academy in North Dartmouth, Mass., announced that **Kay Hudock**, S.M.'78, was appointed the school's new business manager. Hudock was most recently at Wheaton College.

Sloan Fellows

Deceased: **Russell DeYoung**, S.M.'40, of Naples, Fla., passed away May 31, 1988, leaving his wife Lois, two sons, and a daughter. Until 1973, he served as CEO of the Goodyear Tire and Rubber Co., and continued to serve as director and chairman of the board's executive committee until 1979. . . . **B. William Sauter**, S.M.'50, of San Mateo, Calif., died April 17, 1988. No further information is available.

Robert E. Smylie, S.M.'67, was appointed associate technical director of the Space Systems Division at the MITRE Corporation.

In a recent interview with *Mass High Tech* editor Alan R. Earls, **Lawrence Liebson**, S.M.'79, founder of the electronic publishing company Xyvision, said that his company is trying to unify the field of electronic publishing, from personal publishing to higher-quality graphic arts like books and magazines to corporate publishing systems. "The concept has been to put the tools closer and closer to the hands of the originating author or creator or designer," says Earls. His goal is to develop cheap, accessible workstations that will make it possible for designers to work with text and full-color images and lay out publications right there at the workstation. "We see a niche in the high end [towards corporate publishing systems], where it is more of a database management problem to integrate all of the elements of the job . . . and to provide a system that multiple users can interact with."

Program for Senior Executives

Melvin L. Hurni, '58, of Hendersonville, N.C., died April 19, 1986. No further information was available. . . . **Bernard H. Gwynn**, '70, of Edinboro, Penn., died December 8, 1986, leaving his wife, Arla. . . . **Leon A. Sweet**, '57, of Grosse Pointe Park, Mich., passed away March 20, 1988. He leaves his wife, Evoun.

Herbert Kay, '68, was cited by the National Executive Service Corps for his volunteer work on programs to enrich the learning of science and mathematics in secondary schools. Kay, retired from AMAX, Inc., of Greenwich, Conn., helped

design programs that would prepare retired professionals for second careers as public school mathematics or science teachers.

XVI AERONAUTICS AND ASTRONAUTICS

Jay G. Herther, S.M.'86, is an engineering manager working on a prototype of an integrated electronic warfare system for the Stealth fighter at Sanders. He also reports that he and his wife recently were graced with their first child, Jamie Lynne, on May 13, 1988.

Comdr. James W. Neighbours, '41, a retired naval aviator and aeronautical engineering duty officer, retired plant manager for Grumman Aerospace, and a retired manager for Eastern Air Lines, lives in Southampton, N.Y., and is now involved in volunteer work on Eastern Long Island. . . . **Glen J. Kissel**, Ph.D.'88, is presently with the guidance and control section at the Jet Propulsion Laboratory at Caltech.

Robert W. Simpson, Ph.D.'64, director of the Flight Transportation Laboratory at M.I.T., also served on the steering committee for the "Aviation-System Concepts for the 21st Century" symposium held at the Transportation Systems Center in Cambridge this September. "The purpose of the symposium is to support the planning and decision-making needed today to provide for an airport and airspace system capable of efficiently and effectively serving the nation's aviation needs" of tomorrow.

XVII POLITICAL SCIENCE

The second work of fiction by **Steve R. Pieczenik**, Ph.D.'82, *Blood Heat*, was published by Harcourt, Brace, Jovanovich in the spring of 1988. Pieczenik lives in Chevy Chase, Md. . . . **Enid C.B. Schoettle**, Ph.D.'67, of New York City is the director of the International Affairs Program of the Ford Foundation and the mother of two teenage sons. . . . President Reagan announced that **John E. Shephard**, S.M.'85, has been awarded a White House Fellowship. He will serve a one-year assignment as a special assistant to the vice-president, to the members of the Cabinet, or to the president's principal staff. Shephard has been an instructor and assistant professor of social sciences at West Point since 1985.

XVIII MATHEMATICS

Seymour Haber, Ph.D.'54, writes: "In the summer of 1987 I left the National Bureau of Standards to take a position as professor of mathematics at Temple University in Philadelphia."

Not a sensationalist, not an assassination buff: **David E. Scheim**, Ph.D.'75, has added another volume to the shelf of books on the Kennedy assassination. *Contract on America: The Mafia Murder of President John F. Kennedy* was published by Shapolsky Publishers and rates high in the opinions of Kennedy experts and historians alike. Kennedy-specialist John Davis writes that Scheim is "not a mercenary sensationalist, an assassination buff or a career criminologist, but rather . . . a computer systems analyst . . . Mr. Scheim's sole motivation has been a passion for historical truth." Scheim's book constructs the conspiracy almost entirely out of existing evidence gathered by the official investigators, who have for some reason ignored or failed to evaluate the same evidence, and includes analyses of the assassinations of Malcolm X, Martin Luther King, Jr., and Robert F. Kennedy. He also implicates mob rule in the 1933 death of Chicago Mayor Anton Cermak, the 1948 shooting of UAW President Walter Reuther, and the 1961 murder of UAW-AFL President John Kilpatrick. The Mafia is culpable, Scheim writes, and so is the U.S. Government.

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Jean F. Louis, 1932-1988
Urged Technology Shift from
Arms to Space

Professor Jean F. Louis, member of the Aeronautics and Astronautics Department who was an expert in aircraft propulsion and magneto-hydrodynamic (MHD) power generation, died June 21 in an auto accident in Tennessee at age 56. He was attending the International Symposium on Engineering Aspects of MHD in Nashville, where he had presented a paper.

Louis was internationally known for his work and had spent a year as a guest of the Soviet Union's Academy of Sciences while on sabbatical last year. He also investigated methods for shifting the technological effort of the United States from military R&D toward space technology and energy systems, and had been awarded a MacArthur Foundation grant to further his study of "Approaches to Curbing the Arms Race in Space: Alternative Roles for Skilled Technical Personnel."

Born in Belgium, Louis received a Ph.D. from Cambridge University. Before joining the M.I.T. faculty in 1969, he was a principal research scientist at AVCO Research Laboratory and a visiting professor at Stanford University. He served as director of the Fossil Fuels Program of the M.I.T. Energy Laboratory and as associate director of the lab from 1976 to 1981. Louis was also the associate director of the Center for Health Effects of Fossil Fuels Utilization in the Harvard-M.I.T. Division of Health Sciences and Technology from 1978-1982. □

Richard S. Morse, 1911-1988
Invented Frozen Orange Juice

Richard Stetson Morse, '33, entrepreneur, scientist, government advisor, and Sloan School lecturer, died July 1 at his summer home in Falmouth, Mass. He was 76.

Morse received his S.B. in electrical engineering, and seven years later founded the National Research Corporation to develop new technologies and products and then persuade manufacturers to use or make them. Among the company's achievements were vacuum processes to manufacture drugs in powder form, coat optical lenses, dehydrate food while retaining both flavor and vitamins, and re-

fine metals without impurities. He invented frozen orange juice concentrate, helped set up what was to become the Minute Maid Corp., and recruited Bing Crosby's talents to help make it a commercial success.

In 1959, Morse became director of R&D and assistant secretary of the Army under Presidents Eisenhower and Kennedy. He had previously served as a government advisor on chemical, biological, and radiological warfare.

As a senior lecturer at the Sloan School of Management beginning in 1963, Morse taught a popular course in new enterprises, and later set up an experimental foundation at M.I.T. designed to bridge the gap separating the inventor from the investor and manufacturer. He served as vice-president of the Alumni Association from 1953-1955, and was president of the Class of 1933 from 1983 until his death. □

Fred C. Schweppe, 1933-1988
Expert in Electric Power Systems

Fred C. Schweppe, professor of electrical engineering for 22 years, died of a heart attack on July 8 at the age of 54.

Schweppe was a specialist in the pricing and operations of electric power systems, and recently completed work on a book, *Spot Pricing of Electricity*, to be published this fall. He introduced the concepts of network state estimation, which are now an integral part of the control centers for all electric power systems worldwide. The technique makes it possible to evaluate the operating conditions of the power network in order to enhance reliability and control.

After receiving B.S. and M.S. degrees from the University of Arizona and a Ph.D. from the University of Wisconsin, Schweppe joined the Lincoln Laboratory in 1959 as a staff engineer working on control and identification of rocket trajectories. His experience in the difficulties of designing and implementing complex defense systems made him an opponent of current SDI activities.

Schweppe joined the electrical engineering faculty as a visiting associate professor in 1966, becoming a full professor in 1975. He was elected a fellow of the IEEE in recognition of his work in industry and the academic community, of which he was an active participant. □

Deceased

The following deaths have been reported to the Alumni Association since the *Review's* last deadline:

Mrs. Donald G. Robbins, '07; February 10, 1987; Martinsville, Va.
Earle A. Mitchell, '14; May 21, 1988; Fort Lauderdale, Fla.
Harold H. Perry, '17; September 2, 1987; Columbus, Ohio.
Pierre Blouke, '19; December 17, 1987; Beaverton, Ore.
Mrs. Edmund (Winifred) H. MacDonald, '21; May 6, 1984.
Rosalie Margaret Karapetoff-Cobb, '23; July 29, 1987; Jamaica Plain, Mass.
Frederick E. Klutey, '23; March 12, 1988; Wilmington, Del.
Edgar Bilton, '24; February 2, 1988; New York, N.Y.
Calvin A. Campbell, '25; April 20, 1988; Midland, Mich.
James A. Holland, '25; March 20, 1988; Peninsula, Ohio.
Alva B. Morgan, '25; May 31, 1988; Darien, Conn.
Charles E. Peterson, '25; June 8, 1988; Bellingham, Wash.
Harold E. West, '25; December 21, 1987; Essex, Conn.
Edwin L. Wildner, '25; June 13, 1987; Newport News, Va.
Jose De Martino, '26; October 29, 1986; Mexico 7 D F, Mexico.
John E. Longyear, '26; April 20, 1987; Redford, Mich.
John L. Ostborg, '26; May 10, 1988; Springfield, Ohio.
Roland P. Stowers, '26; March 13, 1988; Leesburg, Fla.
Robert S. Hatch, '27; April 17, 1988; Myrtle Beach, S.C.
Howard R. Batchelder, '28; April 20, 1988; Escondido, Calif.
James B. Greeley, '28; April 4, 1988; Clearwater, Fla.
F. Kenneth Miller, '28; August 2, 1987; Akron, Ohio.
William E. Shenk, '28; January 4, 1988; Lambertville, Mich.
Nathaniel White, '28; June 19, 1988; Michelville, Md.
G(eorge) Ridgley McDaniel, '29; November 30, 1987; Painesville, Ohio.
Ralph Vezin, '29; January 9, 1986; Hockessin, Del.
Waldo E. Laidlaw, '32; October 3, 1987; New Market, Ala.
James L. MacKernan, '32; November 18, 1987; Revere, Mass.
Fozi M. Cahaly, '33; July 2, 1988; Belmont, Mass.
Richard S. Morse, '33; July 1, 1988; Wellesley, Mass.
Mario G. Vangeli, '34; March 9, 1988; Naples, Fla.
Robert A. Scribner, '35; June 10, 1988; Manchester, N.H.
Marvine Gorham, '36; June 15, 1988; Los Angeles, Calif.
Donald E. Henshaw, '36; November 9, 1987; Pawtucket, R.I.
Walter Haight, '37; June 8, 1988.
Ralph E. Hughes, '38; February 20, 1988; Everett, Mass.

Since this is the first issue of a new academic year, I once more review the ground rules under which this department is conducted.

In each issue I present five regular problems (the first of which is chess, bridge, or computer-related) and two "speed" problems. Readers are invited to submit solutions to the regular problems, and three issues later, one submitted solution is printed for each problem; I also list other readers whose solutions were successful. For example, solutions to the problems you see below will appear in the February/March issue. Since I must submit that column sometime in November, you should send your solutions to me during the next few weeks. Late solutions, as well as comments on published solutions, are acknowledged in the section "Better Late Than Never" in subsequent issues.

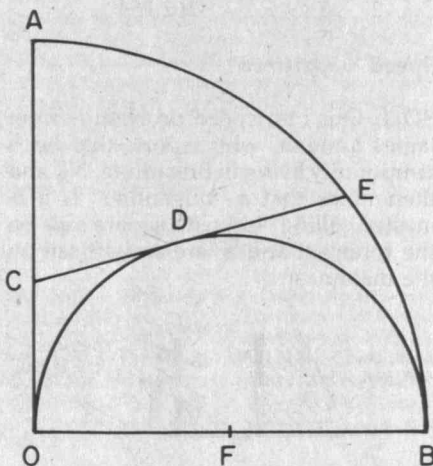
For speed problems the procedure is quite different. Often whimsical, these problems should not be taken too seriously. If the proposer submits a solution with the problem, that solution appears at the end of the same column in which the problem is published. For example, the solutions to this issue's speed problems are given below. Only rarely are comments on speed problems published or acknowledged.

There is also an annual problem, published in the first issue of each new year; and sometimes I go back into history to republish problems that remained unsolved after their first appearance.

OCT 1. We should be proposing a new bridge problem this issue but, unfortunately, I mistakenly omitted a part of the M/J bridge problem. The corrected problem appears in the solution section below and will serve as the bridge problem for this issue. Sorry.

OCT 2. Matthew Fountain's figure shown below depicts a semicircle of radius 1 in a quartercircle of radius 2. What

is the largest area that the curved region ACE may have, if CE is tangent to the semicircle?



OCT 3. Ron Raines sent us the following classic problem. It sounds familiar so I would not be surprised to hear that it appeared in "Puzzler Corner" 15-20 years ago! However, I think it is a lot of fun and worth the risk of being a repeat: On a train, Smith, Robinson, and Jones are the fireman, brakeman, and engineer, but NOT NECESSARILY respectively. Also aboard the train are three businessmen who also have the same names: a Mr. Smith, a Mr. Robinson, and a Mr. Jones.

- (1) Mr. Robinson lives in Detroit.
- (2) The brakeman lives exactly halfway between Chicago and Detroit.
- (3) Mr. Jones earns exactly \$20,000 per year.
- (4) The brakeman's nearest neighbor, one of the passengers, earns exactly three times as much as the brakeman.
- (5) Smith beats the fireman at billiards.
- (6) The passenger whose name is the same as the brakeman's lives in Chicago.

Who is the engineer?

OCT 4. Richard Hess has a two part question that he calls "deduce your number":

Three of you in a room are told you each have a prime number written on your forehead and that they form the sides of a triangle with prime perimeter. Each person is asked in turn if he can deduce his number.



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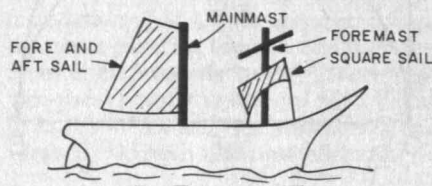
- (a) You see a 5 and 7 and have heard "don't know" from the other two. What is your number?
(b) You see a 5 and 11 and have heard "don't know" from the others on each of their first two turns. You have stated "don't know" on your first turn. It is now your second turn; what is your number?

OCT 5. For some unknown reason, Scott Berkenblit wants to know the largest integer that is less than

$$1 + \frac{1}{2} + \frac{1}{3} + \dots + \frac{1}{162,754}$$

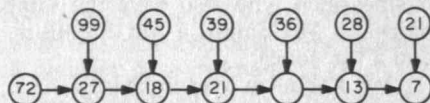
Speed Department

SD 1. Our first speed problem is from James Landau, who reports that he is temporarily living in Brigantine, NJ, and then notes that a "brigantine" is a 2-masted sailing ship with square sails on the foremast and a fore-and-aft sail on the mainmast.



Landau wants to know what, mathematically speaking, is the difference between a square sail and a fore-and-aft sail.

SD 2. Nob Yoshigahara wants you to fill in the empty circle. He warns you that the last 7 is NOT an 8.



Solutions

M/J 1. I inadvertently omitted part of the problem. Specifically, West leads the ten of spades, and East encourages with the seven. How do you play this hand? Hence, the problem is now re-opened and a solution will be given in February with the new problems presented this month.

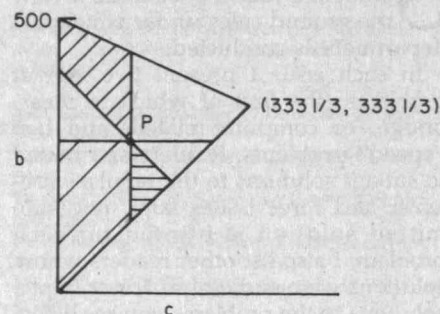
North
♠ 4 3
♥ K 7 6
♦ A Q J 5 2
♣ K Q 5

South
♠ K 6
♥ J 10 8 5 3 2
♦ K 7
♣ A 6 4

Bidding			
N	E	S	W
1D	1S	2H	Pass
3H	Pass	4H	Pass
Pass	Pass		

M/J 2. Two gamblers, High Roller and Poker Face, love to gamble but not with each other, as High Roller always wins at dice and Poker Face always wins at cards. A mutual friend suggests a fair and nontrivial bet that they could make. Each could privately write three amounts adding to \$1,000 on a slip of paper. Then they could compare their amounts, the largest against largest, the smallest against the smallest, and the median against the median. The one with the larger amount in two of these three comparisons would win the bet and take the \$1,000. Can you help Poker Face decide what to write on his slip?

Robert Bart drew the following diagram.



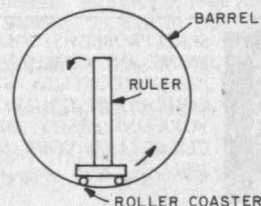
In this picture the horizontal axis is c, the smallest value, and the vertical axis is b, the median value. The space of feasible solutions is the triangle shown. The point P has coordinates (b, c) and $a = 1000 - b - c$ is also determined by P. The first point to note is that the shaded area gives the feasible solutions that lose to P. Hence the goal is to maximize this area. Bart asserts that this occurs (approximately) when $c = 231$, $b = 384$, $a = 385$; which agrees with Robert Buegler's computer search.

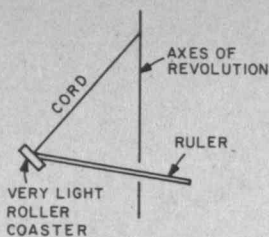
Also solved by Robert High, Winslow Hartford, Ken Rosato, and the proposer.

M/J 3. Imagine a roller coaster with a ruler, initially pointing straight up, balanced on it. Even ignoring air drag, the ruler's attitude is unstable, and it will eventually fall over. Is there a path, e.g. a series of hills and loops, for the coaster such that the ruler's attitude remains stable and it will not fall over?

The following solution is from Matthew Fountain: Two arrangements make it possible. The first diagram shows the path to be the inside surface of a barrel. The width of the ruler makes it stable against tipping in the direction of travel. The centrifugal force acting on one end of the ruler keeps it in contact with the roller coaster while the smaller, opposing centrifugal force on the other end keeps it from tipping over toward an end of the barrel.

The second diagram shows another far-fetched arrangement which will work even if the ruler is a thin rod normally unstable in all directions. A thin rod hanging from a light cord attached to one end and properly set in motion so that its upper end moves in one circle while its lower end moves in a smaller circle 180° behind the upper end will remain in stable rotation. With practice anyone can demonstrate this by starting with the hanging rod at rest and then swirling the upper end of the cord horizontally in a tightening circle. When spinning at constant speed, the center of gravity moves in a circle with constant radius. At constant speed any small departure of the center of gravity from this circle results in changes in the path of the upper end with the result that the tension in the cord varies during each revolution, being greatest when in position to oppose the departure.





Also solved by Robert Bart and the proposer.

M/J 4. Four suspects, each of different height, are in a house surrounded by a posse. The actual criminal is known to be the tallest. The sheriff is constrained to make only a single arrest. The suspects can be arrested only as they leave the building. They do so one at a time. Which suspect—the first to leave, the second, etc.—should the sheriff arrest?

As noted by the proposer and others, it is important to state what assumptions are being made. Here we assume that the suspects come out at random and that the goal is to maximize the probability of getting the correct suspect (but that it is no worse to choose the wrong suspect than not to choose any suspect). With these assumptions Bob High shows that the best strategy is to let the first suspect go by and then arrest the next suspect who is taller than all preceding suspects. Indeed, High generalizes the problem to n suspects and shows that one should then let n/e go by and arrest the next one taller than all preceding. For large n , the chances of catching the criminal are about $1/e$. High's analysis is available from the editor.

Also solved by Winslow Hartford, Matthew Fountain, Robert Bart, Gordon Rice, R.L. Loesch, Steve Feldman, Bob Metcalfe, Norman Spencer, and the proposer.

M/J 5. Given a point, a line, a compass, and a straight edge, construct the perpendicular to the

line through the point using the compass only once and the straight edge as many times as necessary.

The following beautiful (and beautifully drawn) solution below is from Edward Dawson: The given straight line is AB, and C is the given point. With C as a center draw a circle intersecting line AB at points D and E. Using the straight edge draw diameters DG and EF, and chords DF and EG. From an arbitrarily located point H on line AB draw line CH which intersects line EG at point J. Draw line DJ which intersects diameter FCE at point K. Draw line HK extended to intersect diameter DCG at point L.

Point L is harmonic to point G with respect to points D and C, so that $DL:DG = CL:CG$. Denote radius CG by r , then:

$$\frac{DL}{2r} = \frac{CL}{r} \text{ and } CL = \frac{DL}{2} = \frac{r}{3} = \frac{CD}{3}$$

Therefore, as radius CF is equal to radius CE, line FLR is a median of triangle FDE, and $DR = RE$. Hence, CR is the required perpendicular to line AB.

Also solved by Matthew Fountain, Robert Bart, Winslow Hartford, Ken Rosafo, Phelps Meaker, Wilbur DeHart, Mary Lindenberg, Avi Ornstein, and the proposer.

Better Late Than Never

1987 N/D 5. Thomas Harriman, Stephen Kanter, and Jack Bogdanski have responded.

1988 JAN 1. James Poitras, Robert Keston, and Frank Model note that if the Diamonds split 4-2 and the Spade finesse fails, the opponents are likely to cash the A and K of Diamonds and then ruff a third round. Hence it is better to play for the drop rather than the finesse in Spades. To quote Mr. Poitras, "Otherwise, you are playing the suit, not the hand."

F/M 2. The proposer, Frank Rubin, writes that the problem was designed to be open-ended and sug-

gests the following avenues for solutions.

- (1) For $x = y = z = 2$, the well-known formula $(p^2 - q^2)^2 + (2pq)^2 = (p^2 + q^2)^2$ gives a family of solutions. This can be iterated, by setting $p = r^2 - s^2$ and $q = 2rs$ to give solutions of the form $a^2 + b^2 = c^2$, for all n .
- (2) From $2^n + 2^n = 2^{n+1}$ we can factor n and $n + 1$ to get many solutions, like $8^3 + 32^3 = 16^4$.
- (3) From $1 + 2^3 = 3^2$, we can multiply by 3^{3n} to get $(3^3)^n + (2 \cdot 3^n)^3 = 3^{3n+2}$.
- (4) We can multiply any $a^2 + b^2 = c$ by $c^{km(x,y)}$. Similarly, we can multiply any $a^2 + b^2 = c^2$ by $c^{km(x,z)}$.

F/M 3. Robert Buegler has responded.

APR 2. Morton Hecht and Donald Savage have responded.

APR 4. Michael Jung has responded.

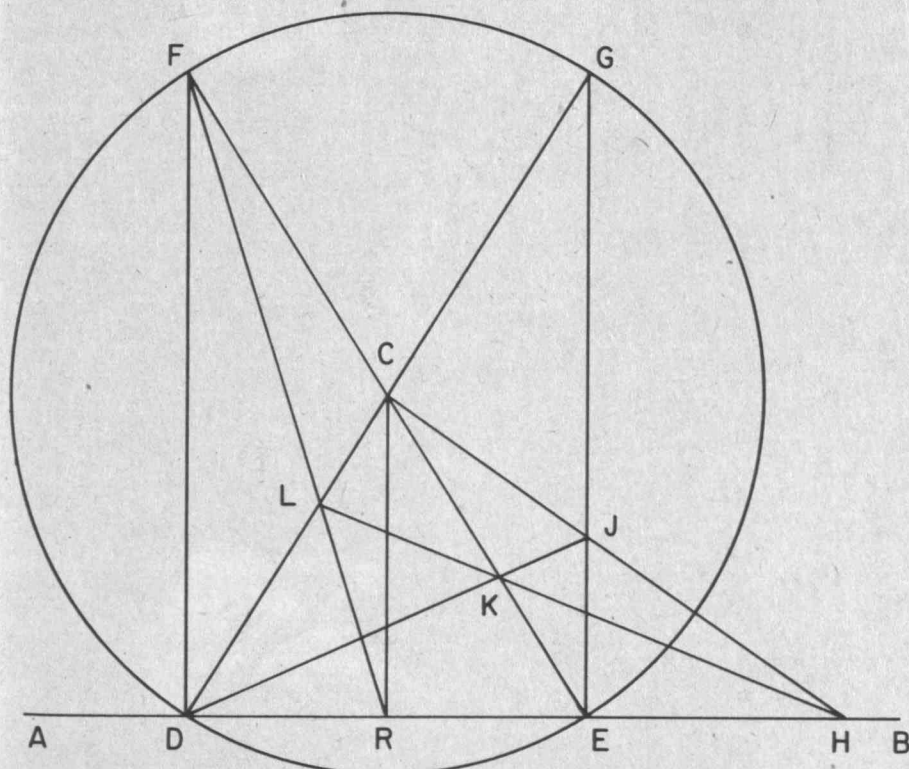
M/J SD2. Robert Keston believes that one should consider the effect of giving the cube to the opponent.

Proposers' Solutions To Speed Problems

SD 1. The answer is geometric but has little to do with the shape of the sails. A square sail can present either vertical edge to the wind, but always presents the same side. A fore-and-aft sail can present either side to the wind, but always presents the same edge.

SD 2. 12.

$$\begin{array}{ccc} 27 \text{ is } & 9+9+7+2 & \\ & \uparrow \quad \uparrow & \\ & (99) & (72) \\ 18 \text{ is } & 4+5+2+7 & \\ & \uparrow \quad \uparrow & \\ & (45) & (27) \end{array}$$



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DONORS' PROFILE:

MR. AND MRS. JOHN JACOB

HOME: Silver Spring, Maryland

CAREER: Mr. Jacob received the S.B. in mechanical engineering in 1926. His career in aeronautics included service as an aviator for the Marine Corps during World War II, a post-war appointment at the National Military Establishment under the Secretary of Defense, and a position as sales manager of United Aircraft International. He has been married to Harriet (Bell) Jacob, a registered nurse, since 1967. Both Mr. and Mrs. Jacob are retired.

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QUOTE: "Pooled income funds are a fine investment," Mr. Jacob says, "particularly for anyone who's holding securities that have appreciated in value, as mine had. You can give them to MIT and avoid paying income tax on the appreciation. I designated the remainder of my gift for the Independent Residence Development Fund, since when I was an undergraduate and president of my fraternity, we had problems finding housing."

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Photo: Dane Penland

company are all firmly committed to deliver just-in-time. Penalties for failure to deliver JIT ensure that commitment. In the case of suppliers, the penalties are financial. In the case of individual workers, management can drag its heels on requests for bathroom relief or vacation, assign additional duties, and even apply formal discipline. NUMMI's rules mandate discipline—including firing—for "failure to maintain satisfactory production levels."

Thus, personal stress as well as system stress drives production. That is one reason why NUMMI and other such operations rely so heavily on a visual display of production like the *andon* board.

"Autonomation" and Technology

Management by stress takes a vulgar Marxist view of the relationship between technology and extracting the most profit from its labor force. The focus is on getting rid of labor that does not directly add value to the product—material handling and most inspection, repair, and cleaning. Automation is never adopted for its own sake. A machine that replaced a production worker but required an additional electrician to service it would be rejected.

Furthermore, automation must increase management flexibility, not decrease it, as can be seen in Monden's warning about possible problems:

Even if the introduction of an automatic machine reduces manpower by 0.9 persons, it cannot actually reduce the number of workers on the line unless the remaining 0.1 person . . . can be eliminated. . . .

[Also, automation] often has the undesirable effect of fixing the number of workers who must be employed at a given workplace . . . regardless of production quantity. . . .

In both respects the introduction of [automation] may actually eliminate the ability to reduce the number of workers—a matter of some concern, since it is always essential to reduce the work-force, especial-

ly when demand decreases.

While plants following the NUMMI model may reject unproven technologies that require highly skilled operators and maintenance backup, they will very quickly adopt and adapt technologies proven elsewhere. Management-by-stress plants emphasize small-scale automation to improve the functioning of the

system—*jikoda* or "autonomation," as it is called at NUMMI and Mazda. These terms refer especially to technology that detects production problems. Autonomation concentrates on such devices as those that shut down the line if a part is not installed correctly.

At the same time, management by stress makes it easier to introduce more advanced or larger-scale technologies. First, since workers must do a job in a machine-like way, management uses them as a prototype for automation. Second, management's ability to flexibly assign workers to new duties and force "cooperation" bypasses many of the usual obstacles to introducing automation.

Thus, management-by-stress plants are not likely alternatives to high-tech plants even though NUMMI points with pride to the fact that it has succeeded without the most advanced technology.

While NUMMI does not

represent the cutting edge in technology, it started operation with 170 robots—more than in many traditional assembly plants. The Flat Rock, Mich., Mazda plant is even more modern, and in 1986 Nissan management claimed that its Smyrna, Tenn., facility had more robots than any other U.S. assembly plant. Honda has announced plans to install a new system in its Ohio plant to automate 80 percent of vehicle assembly and triple productivity.

Stopping the Line

"Workers can stop the line." For those on the assembly line, this promise has come to symbolize the difference between the team concept and "the old way of



*Since workers must
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management uses them as a prototype
for automation.*

doing things." And Toyota and NUMMI present such power as the foundation of their respect for workers. Monden says, "It is not a conveyor that operates men, it is men that operate a conveyor."

The ability to stop the line is extremely attractive. In conventional U.S. auto assembly plants, a worker dares to stop the line only in a dire emergency. At NUMMI, a worker who is making a genuine attempt but cannot keep up just pulls the stop cord, which results in distinctive chimes and flashing lights on the *andon* board. If the cord is not pulled again within a set time to cancel the warning, the line will stop. There is—supposedly—no penalty. This arrangement is even written into the contract.

In fact, during trial and training periods, when the line is very slow, "the cord" seems to benefit everyone. It helps workers get assistance when problems come up, and it helps keep quality high. However, once most bugs are worked out, the cord can become oppressive. As the line goes faster and the whole system is stressed, it becomes harder and harder to keep up. Since tasks have been so painstakingly charted, refined, and recharted, management assumes any glitch is the worker's fault. The chimes and lights of the *andon* board immediately identify the person who is not keeping up.

A worker who is having trouble has four immediate choices, none good. The first one, stopping the line, is likely to attract immediate and unhappy attention from the group leader, who also feels pressure. As a NUMMI manual explains, "The supervisor's first priority is to put the line back into operation as fast as possible. Then it is the supervisor's responsibility to find out the real cause of the problem, and take countermeasures."

Second, a worker can signal the team leader for help, but a leader helping one worker is unavailable for others—creating peer pressure not to take up too much of the leader's time. Third, the worker can let the job go through uncompleted, but then workers down-

stream are certain to pull the cord, again drawing attention to the unfortunate one who fell behind. Fourth, the worker can go "into the hole"—move down the assembly line to finish the task. But catching up is hard when you're already working fast, and jobs are so tightly charted that working into the hole may mean moving into another station, throwing off another person's pacing.

A Mazda worker describes the Catch 22 in which pulling the cord placed one woman:

She had a hard time one day and pulled the stop cord several times. The next day management focused attention on her. Several management officials observed, and they set up a video camera to record her work. She found herself working further into the hole. She worked into the hole too far and fell off the end of the [two-foot] platform and injured her ankle. They told her it was her fault—she didn't pull the stop cord when she fell behind.

In reality, the only solution is to keep up, no matter what it takes. Some NUMMI workers use break time or come in early to "build stock" or get ready. Thus, NUMMI's high productivity figures result at least in part from pushing employees to work overtime for free.

In the worst cases, management installs elec-

tronic supervisors and electric tethers to automate the very item—the cord—that was supposed to symbolize workers' power over production. Toyota has put photoelectric cells in some stations that shut the line down if a worker fails to complete all operations in the allotted time. Similarly, floor-mat sensors automatically stop the line if an operator moves too far from the assigned position.

The Multifunctional Worker

If just-in-time forbids producing in advance and idle time cannot be tolerated, production must be organized so that jobs can be shifted and adjusted easily when demand rises or falls. The ease and speed with



*The chimes and lights
and the "andon" board immediately
identify the worker who is not
keeping up.*

which management-by-stress plants respond to the ups and downs of the market contribute greatly to their high productivity.

Such management flexibility requires that workers be able to perform many jobs. The common name for this is "multiskilling," but that term, like the team concept in general, is misleading. The essence of multiskilling is actually the lack of obstacles—such as contract provisions, job classifications, or tradition—to management's desire to reassign jobs. Management's bogeyman, "outmoded work rules," which in traditional plants prevent supervisors from assigning workers to several types of jobs at once, must go.

The plant's physical layout may also be altered. For example, interchangeable assembly-line jobs might be arranged in a circular pattern to allow workers to move easily from one to another. That layout would help management eliminate one worker and redistribute the tasks to those remaining.

Therefore, during hiring management-by-stress plants show little interest in applicants' skills. Production jobs that have been carefully broken down into simple actions do not require intensive training or specialized knowledge, only manual dexterity, physical stamina, and the ability to follow instructions precisely. Once hired, workers do not learn new marketable skills. Instead, they carry out many extremely "job-specific" tasks that require only practice to do them quickly.

The idea of interchangeable workers also informs the management-by-stress policy on absenteeism. NUMMI and Mazda employ no extra staff to cover for absentee workers. The team leader must fill in for a missing member. But this means that the team leader is not available for his or her regular duties, helping workers when they need relief.

Again, stress is crucial. All the difficulties of one person's absence fall on those in daily contact with the absentee—the co-workers and immediate supervisor—producing enormous peer pressure against absenteeism.

Management's concern with absenteeism is evident even during the hiring process. NUMMI's application form requires workers to specify the number of days missed each year for the previous five years and give reasons for absences in excess of 10 days per year.

The total system successfully enforces attendance. GM claims around 2 percent unscheduled absenteeism for NUMMI, compared with 8.8 percent for the whole corporation.

Personal Stress and Productivity

Team-concept advocates claim that the dignity of the individual is central to their theory. Toyota managers

call it the "respect-for-human" system, and there is superficial evidence of that respect. Visitors to NUMMI are struck by the plant's atmosphere. Workers are addressed using courteous language; the factory is clean and well lit and seems like a nice place to work.

But the operation of the plant indicates a very narrow notion of humanity: human fulfillment is achieved only by striving for management's goals. A manual used at the Michigan Mazda plant warns, "If you are standing in front of your machine doing nothing, you yourself are not gaining respect as a human being." Mazda tells its workers to arrange their personal lives so they can work 10 hours every day although management may assign them only 8. Some stress is addressed by such things as tool design, yet overall the system intensifies stress by continually increasing demands on workers and reducing personal control.

Most of the time, the company's goals do not entirely mesh with those of individual workers, and then choices have to be made. In designing production systems, do we select one that ensures the most fulfilling, safe jobs or one that emphasizes the corporate need to be profitable? At NUMMI and other U.S. auto plants, UAW leaders, anxious to preserve jobs, advocate the team concept as a way to increase companies' productivity. That relates to job security: management has often used the threat of job loss to induce workers to accept team concept. GM workers in Van Nuys, Calif., for example, voted in team concept (by a narrow margin) when the company threatened to close either their plant or one in Ohio. But for all the public talk about the job security the team concept was supposed to provide, interviews with NUMMI workers reveal that fear of plant closings is still uppermost in their minds.

A team structure could be useful to workers on the line—if its purpose were to enhance communication and coordination among peers. But in most U.S. plants, team meetings are simply shape-up sessions where a supervisor transmits information on maintaining quality or announces changes in assignments. In evaluating a team system, it is important to ask: are team leaders selected by the group, responsible to the group, and replaceable by the group? Can the real concerns of team members get on the agenda of team meetings? Can the group discuss problems without the presence of management? Can the group get an unsatisfactory supervisor replaced? Does the group have real authority?

The Humanized Workplace

In asking such questions, we assume that work design should benefit workers. We believe that the enormous increases in productivity brought about by

technology mean we can afford concern for human beings, whether or not we achieve the maximum productivity or profitability. For example, advanced technology can make jobs easier, safer, and more interesting. Computers can honor complex sets of preferences in assigning jobs and hours and even make flextime possible for complicated operations.

Consider automatic guided vehicles (AGVs). Instead of a fixed assembly line, individual carriers guided by computer programs move the car under construction from assembly station to assembly station. Elaborate AGVs can hold a car at different heights or angles for different operations. Computer controls track the location, contents, job requirements, and problems of each AGV. While AGVs can simply be substituted for the traditional assembly line, they could also allow breakthroughs in humanizing work.

Many U.S. auto workers first heard of AGVs and team production as a Swedish method. The Volvo factory in Kalmar was reported to have found an alternative to the boredom of the assembly line. In fact, in a different context from that in the United States—the Swedish work force is 90 percent unionized—European labor organizations have often advocated team programs, reflecting confidence in the ability of unions to shape and control them.

At Kalmar, team production uses an assembly line, but car bodies shuttle from station to station on AGVs rather than travel on a continuous moving chain. Each worker's job includes varied tasks and takes longer than in a U.S. plant. And AGV technology sometimes makes it possible for workers to build up a "bank" and take a break. A new Volvo plant now under construction at Udevall will use larger teams, and more of the car will be assembled at each station.

A Canadian union report on Kalmar points to labor's involvement in designing the plant. It cites the facility's low noise level, the control teams have over

their immediate environment, and the ability of teams to independently vary their work pace.

A 1985 report by a Swedish industry-union board also pronounced Kalmar generally a success, while indicating that the plant was no final answer: "Even though the jobs are consistently given high ratings, many employees feel that assembly work gives too little

room for the exercise of initiative and personal growth on the job." Swedish unionists similarly report that the team system has not produced a utopia. Managers control the AGVs with computers and can make the platforms move whether or not a worker is finished. While experiments with long cycle times continue in other plants, a 1984 reorganization at Kalmar reduced maximum cycle times from 20 minutes to 4.

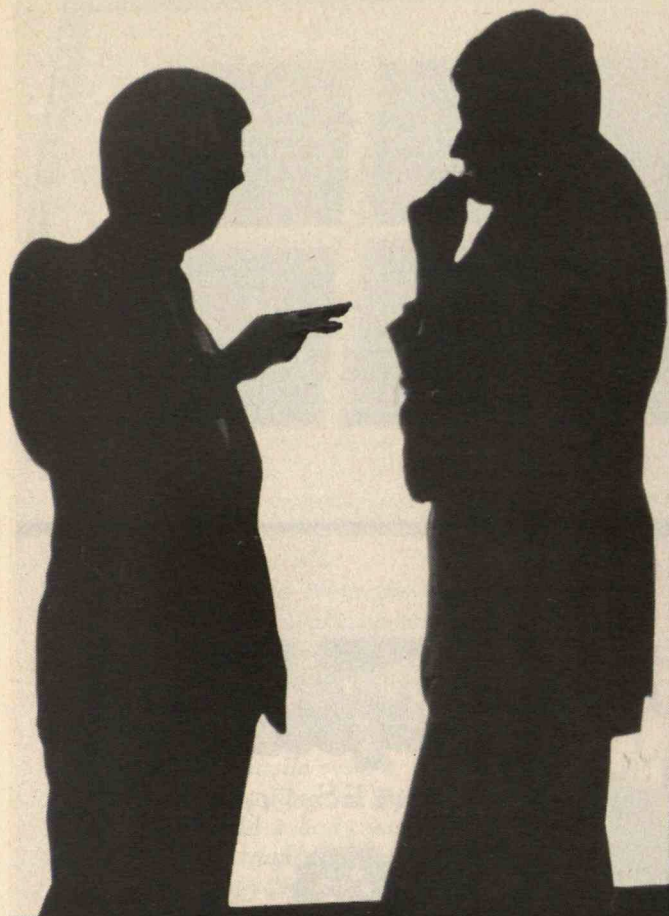
In the United States, the few auto companies that have displayed interest in the Swedish approach have kept implementation of it to dead-ends and side roads. Keith Brooke, a GM specialist in quality of work-life, describes a mid-1970s experiment in which a team of four laid out their work area and assembled an entire van in one location. It took about two days to build a vehicle. The workers were so enthusiastic that they would gather on weekends to iron out problems. As each van

was built, they would place in it a photograph of themselves and a letter with their home phone numbers, inviting customers to call if they had problems. Brooke provides no explanation for why GM dropped the project.

Whatever the virtues of such experiments or the Western European versions of team production, they are not what U.S. auto companies have in mind today. They are adopting team systems because they believe they will increase productivity and quality (read: profits). NUMMI and other management-by-stress plants meet these goals, but at great cost to a humane work environment. □



*In a 1970s GM
experiment, workers would
place a photograph of themselves in
each van they built.*



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HOW JOHN GIBBONS RUNS THROUGH POLITICAL MINEFIELDS:

Life at the OTA

IN the late 1960s the U.S. Congress woke up to the fact that complex matters were demanding more and more of its attention. The supersonic transport jet, the anti-ballistic-missile system, lead-paint poisoning in children: how could a body with few members trained in science and technology evaluate differing experts' advice on such issues? Recognizing the dilemma, Congress in 1972 created the Office of Technology Assessment (OTA).

OTA is the smallest congressional agency. Yet its 140 employees, backed by some 2,000 outside experts who provide technical guidance and help conduct research, evaluate everything from the legality and ethics of unorthodox cancer treatments to the cost of policies that could slow global climate change.

In the politically charged climate of Washington, OTA encounters pressure on all fronts. For that reason it's critical that OTA remain independent, says John H. Gibbons, the agency's director. In the following interview with Technology Review editors Laura van Dam and Robert Howard, Gibbons describes how his agency can conduct unbiased research while steering through the political rapids.

Sometimes the waters are particularly treacherous. The release of OTA's recent report

on the Strategic Defense Initiative (SDI) was delayed by an unprecedented nine-month classification review at the Pentagon. And even when it finally allowed most of the study to be published, the Department of Defense gave scant justification for its decision to withhold three crucial chapters concerning SDI's ability to survive at-

tack. Gibbons explains why the review took so long and suggests ways to prevent a similar occurrence in the future.

Both Gibbons and OTA have come a long way from their beginnings. In the 1950s Gibbons started his professional life as a nuclear physicist at Oak Ridge National Laboratory. He moved into the political arena after studying energy demand and conservation in the early 1970s. OTA got off to a slow start, with two directors in five years struggling over the agency's mission. When Gibbons joined the agency in 1979, one congressional board member slapped him on the back, wished him luck, and told him he was OTA's last chance.

Over the last nine years, Gibbons has turned the agency into a credible and respected outlet for technology-policy studies, churning out an average of 20 in-depth reports a year. "I couldn't pay the tuition for the experience I'm getting," he says.

PHOTOGRAPHS: RICK REINHARD



TECHNOLOGY REVIEW: OTA must find it tricky to conduct reputable research within a political hothouse such as Capitol Hill. How do you work with Congress and not succumb to pressures to support various agendas?

GIBBONS: You mean, how is OTA able to delve into critical political issues and not get blown up in the process?

We work for both parties, and our survival depends on our being able to satisfy all the stakeholders in Congress. Most congressional members welcome scientifically solid information. So that's what we offer them. We have to remember that we can never go one step further, however, and give opinions on what to do, or we would lose our credibility.

One time in a hearing, Representative Beverly Byron (D-Md.) pressed on one of our people for his opinion. He so steadfastly held to his position—that we can only provide options and not make recommendations on specific bills—that she stood up and walked out.

TR: Supposedly, a member of Congress requests a study and you decide whether to go ahead with the work. But surely there's more politicking between your staff and Congress.

GIBBONS: Most often a committee will request a project. But sometimes it results from conversations between someone from OTA and a congressional member or staffer.

There usually has to be a lot of horse trading about the scope of the study. For example, if the Senate Armed Services Committee asks for something on arms control, the first thing we do is find out not only the committee chair's interest, but also the ranking minority member's interest. Then we go to the other committees that have jurisdiction—the Senate military appropriations subcommittee and similar groups on the House side—to find out how they would like us to treat the subject. By the time we have put a proposal together, we will have identified the stakeholders in Congress and combined their interests into a single piece they can abide by. We try to be an agent of integration within Congress.

Of course, that means we've got a lot of customers out there who will claim that they requested the report. The issuance of a report is newsworthy, and such events are currency for people who have to get reelected. In one recent case, a couple of committees of Congress each wanted to release a finished study. Since both had a role in requesting the study, they arranged for a simultaneous presentation.

TR: How do you avoid being used unfairly by members of Congress?

GIBBONS: Our congressional board protects us.

Its members range from conservative to liberal—for example, from Orrin Hatch (R-Utah) to Ted Kennedy (D-Mass.). The board has six members from each party, and someone is always sure to recognize political subtleties in a proposal or study. There's a political Archimedes principle: you stay upright by having pressure applied from all sides.

TR: Has your board ever voted to withhold a study?

GIBBONS: No. But there was one close call. In 1985, the board voted 7 to 5 to release our first major assessment of SDI, which was quite critical of President Reagan's plan. Two board members felt strongly that it was biased and inaccurate work. They wouldn't give us any details; they just blasted it sideways. But once the board members had voted, they all walked away from the ruckus.

They could do that and remain friends because they had each known about the study ahead of time. As long as politicians are not caught by surprise, they can handle almost unbelievably bad news with great élan.

TR: Do other federal agencies ever give you a hard time?

GIBBONS: Yes, every now and then—usually the defense or intelligence community. For example, it was very difficult to get our hands on classified cost estimates when we were researching alternative basing strategies for the MX missile, a study we finished in 1981.

It was so difficult that Senator Ted Stevens (R-Alaska), who chaired our congressional board at the time, publicly criticized then-Secretary of the Air Force Verne Orr at a hearing for not giving OTA crucial information. You don't want to do that very often. The same folks who get chastised by one of our board members are the people we have to work with next month on some other project.

We also had some pressure from a high-ranking individual in the Food and Drug Administration (FDA) when we studied the safety of releasing engineered organisms into the environment. He kept saying, to both the public and the press, that our draft report was too alarmist. He pushed us hard to be more optimistic. The final, published report said that field testing presented no cause for alarm, but that regulators and scientists should remain cautious. Our position did not change because of the FDA employee's remarks. We really got mad at the interference, because we were criticized publicly before we had come out with our findings. Finally, I had several board members write the FDA administrator, telling him to call off his dog. We haven't been bothered by that person since.

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TR: You've said OTA is so concerned about not appearing to support one side when it comes to hot political topics that you make sure each position is backed by an equal number of findings in your reports. When has that happened?

GIBBONS: When we studied the relative value of cooperating with the Soviets in energy development, we had to make sure we didn't present an odd number of policy options. It was such a balanced issue in terms of congressional votes that if we had presented three instead of four findings, that might have triggered a sense that the option in the middle—which was clearly neither right nor left—was best. We work hard to give equal attention to arguments on both sides of issues.

But OTA will make definitive findings if there's a solid, analytical, objective basis for them. In May we released a study on the capabilities of the latest technologies for detecting nuclear tests and distinguishing them from other explosions. Our numbers concerning the force of underground tests that you can monitor with assurance are about 15 times lower than what the Reagan administration maintains. We expected to get hit around the head and shoulders on this, but we were ready to stand our ground.

Foot-Dragging on the Star Wars Report

TR: Your recent study of SDI caused a lot of controversy. Had you ever run into trouble over classification before?

GIBBONS: Few OTA studies require classification review. In the last five years only a half-dozen of all of our studies have used classified information.

Under the Constitution's separate-but-equal doctrine, the legislative branch can decide for itself what should be classified. But our philosophy is that while OTA may have some strong ideas as to what is secret information, we'd rather not trust ourselves—especially if we have access to classified information from the executive branch. So we always take the advice from other agencies seriously, to the point that one study was never released. Our master tapes were sent to the Pentagon and destroyed.

TR: What was the topic?

GIBBONS: Strategic command, control, and communication. Just too hot. We made an arrangement with the Defense Department that if people within Congress needed to be briefed on the matter, DOD would brief them. Charles Bowsher, the comptroller general of the United States and head of the General Accounting Office, tried to get a copy of the study from me, and I couldn't let him have it. Jack Brooks (D-

Texas), the powerful chairman of the House committee on government operations, wanted a copy, and I couldn't let him have it, either.

As for delays in classification reviews, the one over our recent SDI report was by far the longest—nine months. While the SDI organization (SDIO) had nominal responsibility, the whole of the defense community checked the study out, including the secretary of defense, the armed services, the labs like Livermore and Sandia, and the Central Intelligence and Defense Intelligence agencies. Some of the armed services were willing to sign off on a chapter, while another would say the whole thing ought to be classified.

If anyone said no, the draft had to go back to the office of the secretary of defense. We were caught in the middle of the parade.

At one point, we thought everybody had signed off—and then a new security guy at SDIO recycled the draft and found somebody new who objected. Finally, after mounting congressional pressure, SDIO argued last spring that all but the three chapters on the system's ability to survive attack were unclassified. DOD concurred in late May.

TR: O'Dean Judd, SDI's chief scientist, said that some of the report's conclusions—such as the finding that the SDI software might fail if the system were attacked—were overly pessimistic. Was that why the review took so long?

GIBBONS: You always have to worry about whether the process at the Pentagon is political or strictly pertains to military secrets.

But I see all kinds of evidence that what held up the study was simply procedural: sending the report to so many parties. In fact, in the last round it went back to one agency and they reversed their opinion. While the SDIO office did suggest some "less pessimistic" wording, I don't believe they tried to hold up the report for that reason.

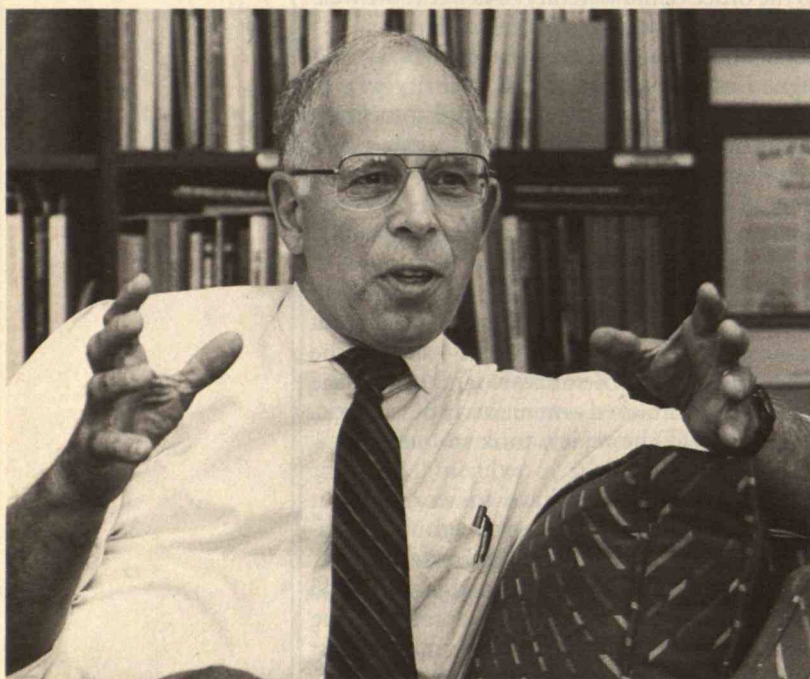
TR: Did the delay keep Congress from learning about your findings during hearings over funding levels for Star Wars?

GIBBONS: Technically, no. The classified material was delivered to Capitol Hill in late August of last year, in time for the appropriations hearings. Since every member of Congress is automatically cleared on a need-to-know basis, each legislator was theoretically able to read the report. But most legislators didn't, because they might forget what was classified and say something they shouldn't. Many members wanted an unclassified report. And I think properly so.

TR: Do you know why the last three chapters weren't cleared? United Press International quoted an unnamed senior government official



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IN THE RECENT STUDY ON SDI, THE THREE CHAPTERS THAT REMAIN CLASSIFIED CONTAIN ABSOLUTELY NO SURPRISES FOR THE SOVIETS. YOU HAVE TO ASK WHY THEY'RE DENIED TO THE AMERICAN PEOPLE. ”

as saying that they contain no more secret information “than the man in the moon.”

GIBBONS: I agree. The three chapters have been thoroughly cleaned. They contain absolutely no surprises for the Soviets. You have to ask why they're denied to the American people.

There is no word, sentence, or paragraph in any of those chapters that the Pentagon will identify as the classified issue. The defense community says it has to do with telling the Soviets which possible countermeasures and survivability measures the United States takes most seriously.

As far as we're concerned, this argument is extremely fuzzy. We and the Soviets must both take all possible countermeasures seriously. And I believe that a number of people in the defense community, including SDIO, agree.

I'm greatly disappointed that these chapters were held back, because the question of survivability and reliability of countermeasures is at

the heart of some of the claims and counterclaims about SDI. If a determined adversary can knock down your \$5 gadget for \$4, then you lose. That discussion is the basis of arms negotiator Paul Nitze's arguments about SDI, and it's the crux of the debate that Congress has been having over what to do with SDI.

TR: What lessons do you draw from this episode?

GIBBONS: What happened with the SDI study highlights a generic problem between the legislative and executive branches. Constitutionally, they're separate. But sometimes the legislative branch comes to the executive branch for a cooperative review of work. This process has always been ad hoc. It needs to be codified so you know where things are and why they are being delayed. And we need mechanisms for keeping things on track.

It would help if there were a process in which those who would delete information were obliged to explain and defend their reasoning. It would also be a good idea for OTA to work directly with an official who had the authority to approve substitute language. And it would help if there were a mechanism for third-party appeal for expediting the review process.

Time to Get Out the Scalpel

TR: What issues do you see as especially important in the years to come?

GIBBONS: Up and down the line, OTA will get drawn into the argument of how we can surgically trim the U.S. budget so we cut the fewest nerves and blood vessels. OTA is seen as a skeptic about big science because it's always trying to figure out how to do something for less. But across the board, the United States is going to have to grapple with such cost-cutting.

Take space stations. How do you continue U.S. space activities in a productive way but at a much lower price? And look at our growing problem of paying for health care. How can you constrain the rising costs of private health insurance and Medicare yet not choke off innovative R&D in health technology? That's a tough, tough issue.

Another increasingly important issue is how the U.S. can get at the international balance-of-payments problem. What is our future in world trade? We have to remember that part of the answer will depend on how much attention we pay to social issues such as education. In the long term our economic hopes depend on human resources. So far we haven't spent much time thinking about the social processes by which we manage technology.

The development of more international efforts and agreements is another up-and-coming

issue. Consider global climate change. Here international agreements are imperative because many countries will have to act together if we hope to make headway. Or take research at the frontiers of technology, such as the proposal to map the human genome or develop fusion power. Because of their expense, these projects make sense only if you undertake them globally.

And after all, science moves rapidly across international boundaries today. If worldwide scientific exchange was important when we were light-years ahead of the rest of the world, it is much more important now that other countries are coming up with a lot of good ideas, too.

TR: You must get flak over such notions from people on Capitol Hill.

GIBBONS: Some people believe that we should go it alone as a matter of national pride. The notion stems from the myth that the United States has all the good science. I think OTA's reports on the future of fusion energy and high-temperature superconductivity showed that such thinking is stuff and nonsense. First-rate work is being done in several countries in both of these fields. It's the same with the supercolliding superconductor. Up to the point of specific applications, there is mutual self-interest in international cooperation.

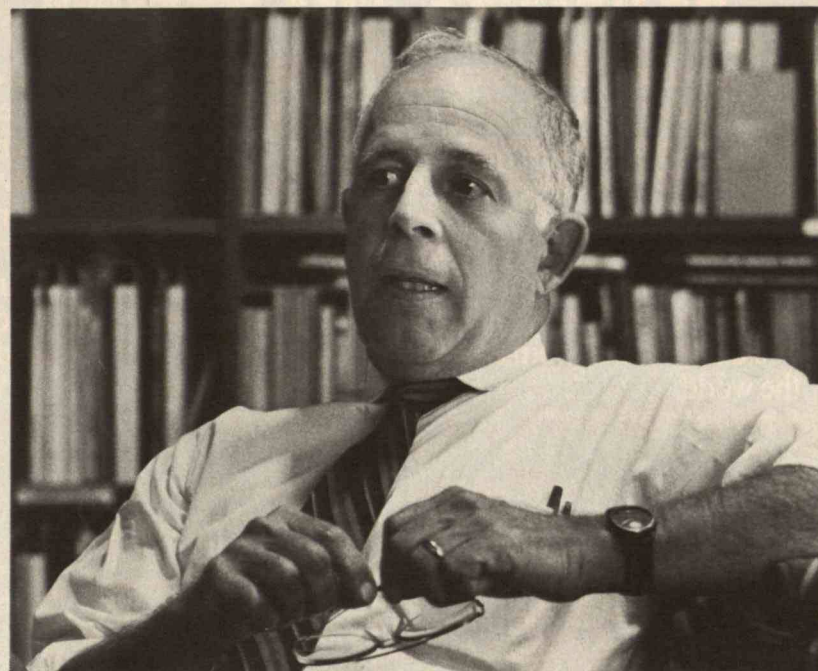
And as for seismic verification, if we can work with the Soviets—as we are now doing a little bit—then we will set an important precedent for the whole world when it comes to treaties between wary partners.

TR: You claimed recently that military defense hasn't really been defense up until now, it's been offense. But you said we could develop systems that are truly defensive. What did you mean?

GIBBONS: Almost every powerful defensive system is also a powerful offensive weapon. You have to be very imaginative to think up a system that is potent yet purely defensive. But it can be done. For example, you could devise a strategy in Europe to replace tanks with in-place antitank weapons. They couldn't rumble across the borders, but they could sure as hell destroy a tank when it came within range. And suppose both the East and West pulled their troops farther from the border so it took more time for either side to make a threatening move that could trigger a confrontation.

TR: Your broad outlook on technology is a far cry from your beginnings. Why did you switch from doing science to analyzing the social effects of technology?

GIBBONS: My wife keeps asking me that. Some of the most enjoyable years of my life were spent poking around trying to figure out if we were



really made of star dust.

When you're conducting scientific research, the easiest thing is to tackle the technical issues. As you move toward the political and social implications, you get nervous because you're on less familiar ground. But I slowly got converted. By the time I was offered this job, I had become convinced that this kind of analytical work is an excellent idea. It gives both officials and the public better access to knowledge—and that's giving them power.

At my first OTA congressional board meeting, I had the temerity to quote from a poem by Edna St. Vincent Millay: "Upon this gifted age in its dark hour, falls from the sky a meteoric shower of facts, they lay unquestioned and uncombined. Wisdom enough to leach us of our ill is daily spun; but there exists no loom to weave it into fabric." I think that is OTA's job—to weave together all of these marvelous and complicated facts in such a way that Congress has access to them. □



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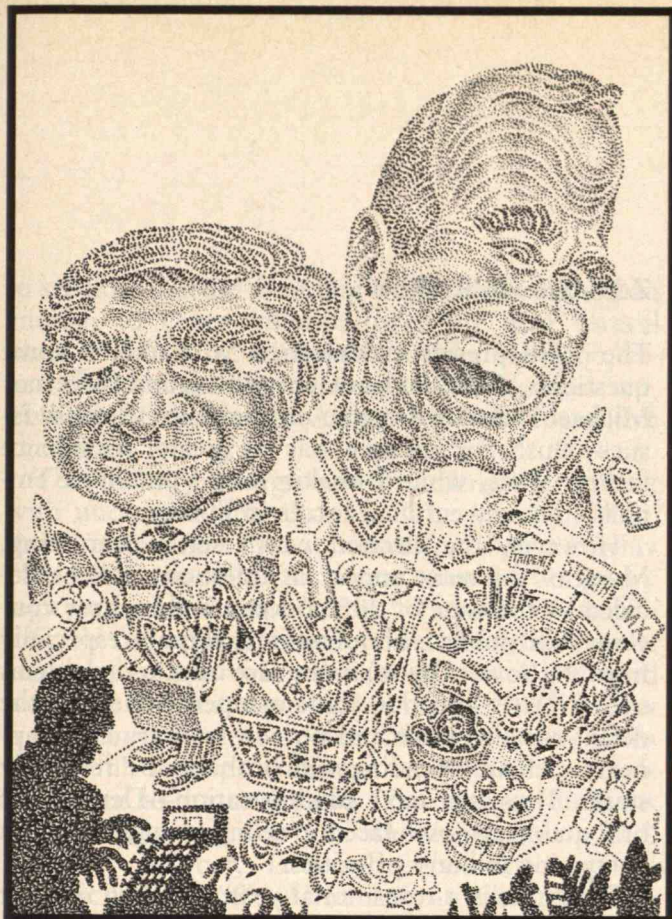
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Defense Policy After the Crash

No matter who wins the 1988 elections, financial realities will force an unprecedented debate on U.S. security objectives.

HARD CHOICES

ON November 23, 1987, the day Frank Carlucci was sworn in as secretary of defense, his deputy, Howard Taft IV, ordered the Army, Navy, and Air Force to each cut \$10 billion from their original 1989 budget requests. Taft also admonished the services to diminish their budgetary expectations for the next five years by up to \$100 billion each. After seven years of prosperity, the Pentagon had suddenly entered an era of fiscal austerity.

Long before that day, it had become obvious that Congress would not approve the \$332.4 billion in fiscal-year (FY) 1989 spending originally requested by the Defense Department. With a mounting federal deficit and worldwide economic jitters, lawmakers were in no mood to accept the 10 percent increase sought by the outgoing secretary of defense, Caspar Weinberger. And while Weinberger would have bullied Congress to the end, his successor chose a more realistic approach. "It is becoming very clear to me," he told a confirmation hearing, "that we may well be talking about a different kind of force [than the

one Weinberger envisioned], at least a different size military force."

That statement is symptomatic of a new consciousness in Washington. While the early 1980s led strategists to believe that anything was possible as far as arms procurement was concerned, the 1990s are emerging as a time of scarcity. Pentagon officials will be forced to make some hard choices among an array of formerly untouchable military projects. And because each major project has its own constituency of contractors, congressional leaders, service chiefs, and political groups, we can expect bitter fights over each proposed cutback—fights that will raise basic questions of national defense and foreign policy.

Until recently, there has been relative unanimity on the basic components of U.S. national security: a strong and varied nuclear arsenal able to absorb Soviet assaults and strike back with devastating effect; large, well-equipped conventional forces in Western Europe and the Northwest Pacific; and a robust capability to patrol and intervene in the Third

BY MICHAEL KLARE AND DAVID CALLAHAN



HARD CHOICES

UNTIL RECENTLY, THERE HAS BEEN RELATIVE UNANIMITY ON THE BASIC COMPONENTS OF U.S. SECURITY, INCLUDING LARGE, WELL-EQUIPPED CONVENTIONAL FORCES IN EUROPE.

World, especially the Persian Gulf. As a result of the budget crunch, however, U.S. leaders are asking what missions can be downgraded or eliminated and where it is safe to impose money-saving economies.

What we face now is an unprecedented debate on U.S. security objectives and the size and character of the forces needed to carry out policy. Once-sacred commitments like those to NATO and Japan are being reexamined in light of the vast imbalance between U.S. defense spending and that of affluent allies. Strategists are also questioning the need for a mammoth nuclear arsenal and an expanding fleet of costly supercarriers.

In dispute are such critical issues as how threatening Soviet forces should be viewed in the Gorbachev era, and how to rate the threat posed by other possible adversaries, including China, Cuba, Iran, Libya, and North Korea. Now that the Intermediate-Range Nuclear Forces (INF) treaty has been signed, policymakers are also reconsidering the emphasis placed on nuclear versus non-nuclear arms, as well as reevaluating the role of costly sophisticated weapons that do not always live up to expectations. To a great extent, the decisions on such matters will determine the type of military this nation deploys in the 1990s and beyond.

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Zero-Growth Realities

The 1988 presidential election will resolve some questions. Vice President George Bush and Governor Michael Dukakis disagree on many key defense issues—Bush, for instance, has far greater confidence in Star Wars, while Dukakis would put more emphasis on conventional forces in Europe.

However, the election won't settle everything. Many of the most important questions will be decided by the state of the economy and by how concerned the public is about military threats (especially from the Soviet Union) in the face of other problems such as AIDS and U.S. trade competitiveness. If the deficit remains large and no new military crisis appears, defense spending will probably be relatively static. Thus, the next administration—Democratic or Republican—will face a grueling struggle between competing military priorities.

Since this is a transitional year, Carlucci did not attempt to resolve such major differences. Instead, he has distributed the fiscal 1989 cuts more or less evenly throughout the military establishment, requesting a \$299.5 billion allocation that would reduce troop strength by 36,000 and eliminate 18 mostly minor weapons programs.

While this no doubt represents a serious blow to services accustomed to large annual increases, one should not conclude that the United States is about to witness an erosion of military strength. The FY 1989 Pentagon budget is still 39 percent higher than that of 1980. Between 1981 and 1987, the Defense Department took in \$410 billion more (in constant 1988 dollars) than it would have received had spending remained at the 1980 level. This windfall enabled the services to acquire a cornucopia of sophisticated weapons, including tanks, personnel carriers, aircraft, helicopters, ships, and missiles. Moreover, Carlucci's proposed annual increases of over 2 percent per year in uninflated terms would push military spending to \$370.2 billion in 1993.

Congress will no doubt resist even modest increases. If the deficit doesn't fall in accordance with the Gramm-Rudman-Hollings Act, defense appropriations could be automatically "sequestered," or cancelled. Unless Congress approves new taxes or the economy surges, therefore, the best the military can expect is zero growth in real, uninflated dollars. "Even under the most optimistic scenario," Sen. Sam Nunn (D-Ga.) observed in February, "it is difficult

to see how defense spending will increase more than enough to cover inflation over the next several years." This is sobering news for the Pentagon, especially coming from someone with the hawkish sensibilities of the Senate Armed Services Committee chairman.

The military has greeted its immediate setback with understandable dismay. "The Crash of '89," *Army* magazine called it, observing that the Army "has been compelled to retreat from the budgetary high ground of the mid-1980s." Yet senior Pentagon officials still appear to believe that Congress can be coaxed into approving dozens of new high-priced weapons. Far from retrenchment, the 1989 budget would continue development of several costly items whose full-scale procurement would add hundreds of billions to future requests. This category includes the MX "rail garrison" missile-basing system, B-2 "stealth" bomber, Trident-II submarine-launched ballistic missile, SSN-21 nuclear attack submarine, advanced tactical fighter, V-22 Osprey tilt-rotor aircraft, and C-17 cargo plane.

In fact, the simultaneous development of these programs would make a zero-growth regime far more painful to the Pentagon, if not to security, than it might appear at first. Because the Pentagon did not eliminate any "big ticket" items in FY 1989, all of these weapons programs will be competing with one another for scarce funds in the years ahead. What appears inevitable, therefore, is a clash between the defense establishment's procurement policies and economic reality. Something will have to give. Administration and congressional leaders will have to look very hard at current military programs

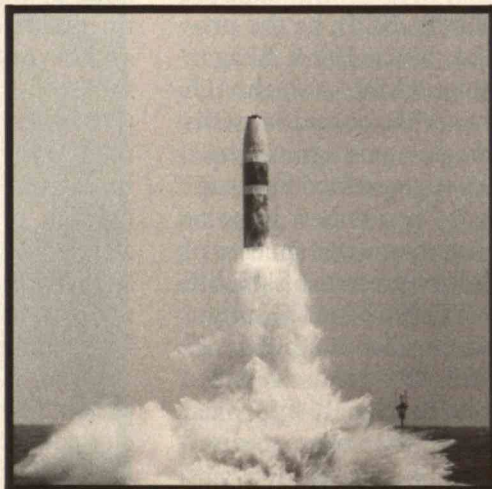
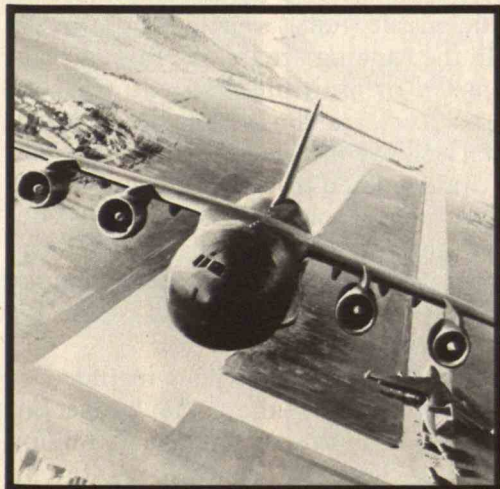
and begin weeding out those that cannot be fully justified.

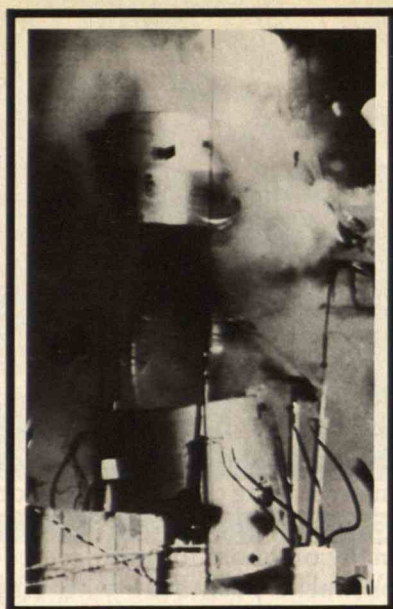
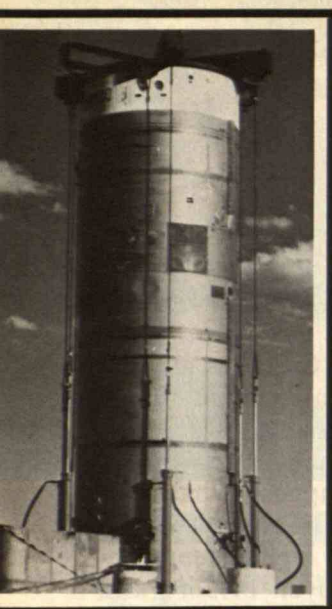
To further complicate matters, Congress and the Pentagon must deal with the continuing fallout from the massive military procurement scandal. Although the full dimensions of the scandal are not yet known, many leading defense contractors appear to have had extensive dealings with Pentagon consultants—many of whom formerly served in high Defense Department positions—who employed bribery and "old boy" connections to obtain classified data on military contract negotiations. That data reportedly was used to rig research and production bids on major weapons systems. Many of the programs thus tainted—including the B-2 bomber, advanced tactical fighter, and V-22—already face stiff battles over future spending levels. How the scandal will affect individual projects cannot now be determined; it is certain, however, that revelations of this sort will intensify the debate over military appropriations.

In the impending battle, each service is likely to tout the unique importance of its own activities and to dismiss or deride the corresponding claims of its competitors. "As you go into a budget freeze or a

HARD CHOICES

THE 1989 BUDGET INCLUDES ITEMS SUCH AS THE C-17 CARGO PLANE, TRIDENT-II MISSILE, AND V-22 TILT-ROTOR THAT COULD ADD HUNDREDS OF BILLIONS TO FUTURE REQUESTS.





HARD CHOICES

WHILE TESTS ON POSSIBLE STAR WARS COMPONENTS CONTINUE, SDI RESEARCH IS UNLIKELY TO REACH THE ASTRONOMICAL LEVELS ANTICIPATED A FEW YEARS AGO.

budget decrease," former Army chief of staff Gen. Edward C. Meyers pointed out last November, "the services immediately start feeding on each other like a pack of piranhas." Recent reforms of the joint chiefs of staff have supposedly eliminated internecine struggles, but few observers question the intensity of the approaching contest.

Star Wars

The first battleground is likely to be the controversial Star Wars program, since 1983 the most costly item in the Pentagon's R&D budget. No recent military program has received as much presidential support as the Strategic Defense Initiative (SDI), as the program is termed in Washington. Since 1983, Reagan has thrown his full weight behind SDI, even though many analysts think it will never work and imperils the chances for a major strategic-arms agreement.

All top Pentagon officials have expressed firm support for SDI. Affirming that it "is our best hope to protect our allies and ourselves from the specter of nuclear destruction," Carlucci requested \$5.03 billion for Star Wars R&D in FY 1989—\$1.7 billion below the original Pentagon projection, but a 23 percent real increase over 1988. The House reduced the figure to \$3.5 billion, while the Senate approved \$4.55 billion. A conference committee compromised at \$4.1 billion.

Whatever the final amount, the program won't proceed at the pace sought by the president. Gov. Dukakis has made no secret of his opposition, calling Star Wars "a fantasy, a technological illusion"; Bush, while promising "to pursue and support fully the Strategic Defense Initiative," is not likely to give SDI the attention lavished on it by his current boss.

Both fiscal and technical impediments are slowing SDI's growth. Congress will not vote higher sums for a controversial program when any increment would have to be balanced by cuts in established military hardware. That reluctance is compounded by skepticism regarding SDI's technical feasibility. Most recently, studies by the congressional Office of Technology Assessment and the Defense Science Board have highlighted concerns about the ability of computer systems to control all the sensors, relay stations, and weapons platforms to be incorporated in the finished SDI network.

At this point, few policymakers call for canceling SDI altogether. Rather, the consensus seems to be that research should proceed at its current rate, and that space-based testing—especially of systems that could violate the 1972 Anti-Ballistic Missile Treaty—should be postponed to the mid or late 1990s. Depending on who gets elected to the White House in November, SDI research could be constrained further or pumped back up, but Star Wars funding is unlikely to reach the astronomical levels anticipated a few years ago.

Land-Based Missiles

After Star Wars, the most hotly debated weapons issue could be the choice of a land-based intercontinental ballistic missile (ICBM) system for the 1990s and beyond. In the running are the MX rail-garrison system, composed of multiple-warhead missiles placed on railroad cars, and the Midgetman, or small intercontinental ballistic missile (SICBM) that would be carried on armor-plated trucks. Both systems are mobile, offering some protection against a Soviet strike aimed at our land-based missiles. They differ in their retaliatory capabilities: the MX could launch up to ten warheads at separate targets, while the Midgetman could fire only one.

Originally, the Defense Department intended to proceed with both systems—the 1988 budget included \$1.27 billion for the MX and \$682 million for the Midgetman. However, economic realities in-

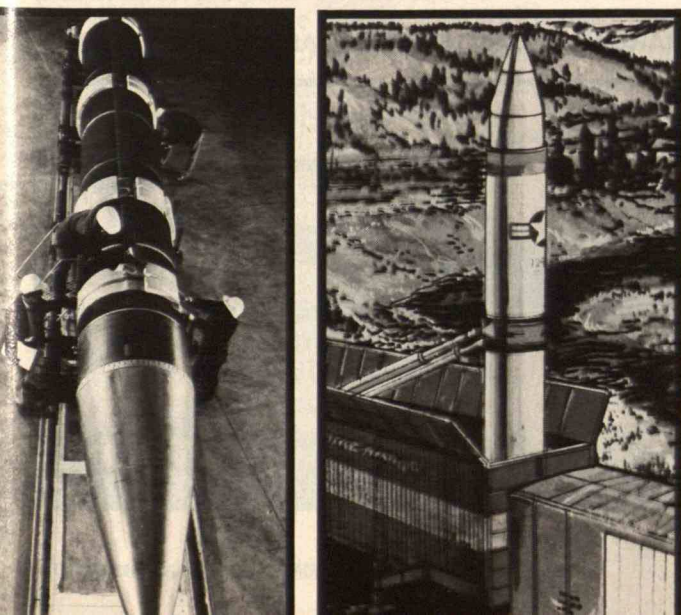
tervened, and the Pentagon had to choose. "It's no secret," Carlucci said, "that we in this building feel that two such systems, given the resource constraints, are unaffordable." He opted for the more completed and powerful system, the MX. The Pentagon requested \$1.68 billion for it in FY 1989, retaining \$200 million for R&D on the Midgetman.

Many Democrats think Carlucci made the wrong choice. Long opposed to the highly accurate, war-head-laden MX as a potential offensive, first-strike weapon, they have advocated the less threatening Midgetman. A smaller missile, they argue, would be more mobile and hence better able to survive an attack. The Midgetman would "ensure that there is never a payoff for either side to strike first with nuclear weapons," the Democratic Policy Commission affirmed in 1986, reflecting the views of senior party officials. The Democratic-controlled House voted to reverse the priorities, providing \$600 million for the Midgetman and \$100 million for the MX. The Senate voted full support for the MX, and a conference committee decided to award each system \$250 million, with another \$250 million set aside for whichever missile the next administration favors.

With Democrats behind the Midgetman and Republicans for the MX, Congress is headed for a show-

HARD CHOICES

WITH DEMOCRATS BEHIND THE MIDGETMAN (LEFT) AND REPUBLICANS FOR THE MX, CONGRESS FACES A POST-ELECTION SHOWDOWN.



HARD CHOICES

BUSH IS LIKELY TO REAFFIRM REAGAN'S COMMITMENT TO A 600-SHIP NAVY, BUT DUKAKIS HAS EXPRESSED DOUBTS ABOUT SUCH PROJECTS AS ADDING CARRIER GROUPS.

down after November's presidential and legislative elections. A Dukakis victory would probably doom the rail-garrison mode but not necessarily ensure the Midgetman's triumph. A Bush victory would boost the MX but not necessarily kill the SICBM.

The 600-Ship Navy

Other than SDI, the U.S. Navy has been the principal beneficiary of the Reagan buildup. Now, however, a struggle over naval spending is likely to be joined by a vigorous debate over strategy.

For the time being, fiscal austerity has brought about few changes in Navy planning. As Carlucci stated in his budget message, "Our [naval] force objectives are essentially unchanged from those established seven years ago." In 1980, the United States had about 480 ships at sea; today there are 580. The \$485 billion spent on shipbuilding over seven years has bought 2 carriers, 3 reactivated battleships, 14 cruisers and destroyers, 30 frigates, and a wide assortment of advanced aircraft and missiles. Retiring 16 older frigates will only temporarily defer the Navy's long-cherished sea power of 600 ships.

The Navy's ambitions are outlined in its 1988-92 shipbuilding plan, which calls for 99 new vessels—5 Trident ballistic missile submarines, 15 attack submarines, 3 carriers, 23 cruisers and destroyers, and a host of lesser warships. The 1988 budget alone allocated some \$13.3 billion for 2 aircraft carriers, 5 cruisers, and 8 other ships, and the FY 1989 budget contains \$8.3 billion for 17 new ships.

The long-term fiscal implications of this plan are clear. The Navy will be committed to obtaining personnel, weapons, electronic gear, and supplies for at least two dozen additional ships. The costs will be

staggering. For example, each Nimitz-class nuclear carrier must be equipped with 90 aircraft, dozens of missiles, and 6,000 sailors—all of which will have to be accounted for in future budgets. It is hard to imagine how the Navy will adapt to static budgets.

Thus the next administration will face difficult choices. Bush, with his background as a naval pilot during World War II and his strong loyalty to the Reagan military agenda, is likely to reaffirm the 600-ship goal. Dukakis, however, appears ready to slacken the buildup and forego further procurement of costly vessels like the Aegis-type guided-missile cruiser, a \$1 billion floating computer system. (The *Vincennes*, involved in the July shoot-down of Iran Air flight 655, was a cruiser of this type.) Dukakis has also expressed doubt about another pet Navy project: "What good does it do to build two additional carrier battle groups at a cost of \$18 billion each when we don't have enough munitions for the thirteen we already have?"

Underlying the funding question is growing doubt about the Navy's 1980s military doctrine. The so-called maritime strategy, propounded by Reagan's first Navy secretary John F. Lehman, Jr., emphasizes supercarriers and other combat ships designed for a direct war with the Soviets. But such vessels remain vulnerable to precision-guided munitions. And in stressing carriers, the Navy has neglected less glamorous functions such as minesweeping, escort service, and amphibious warfare—leading to persistent difficulties in the Persian Gulf.

Conventional Forces for Europe

Like the Navy, the Army faces a fundamental debate over its roles and missions. To a great extent, this debate hinges on the troop commitment to NATO. Representing the largest overseas deployment of U.S. ground forces, NATO accounts for about 40 percent of the 1989 U.S. defense budget—\$120 billion.

The NATO debate harbors two contradictory impulses. On the one hand, many policymakers argue that bolstered conventional forces must compensate for the nuclear arms eliminated under the INF Treaty. Others insist on lowering U.S. troop levels to reduce the budget deficit and prod our allies into assuming more of the cost of defending Europe. Caught between these opposing views is the Army, which seeks to evade the budget axe long enough to complete a modernization program begun in 1975

to replace Vietnam-era equipment.

NATO's historic policy has been to offset assumed Soviet superiority in conventional forces with U.S. nuclear weapons. Accompanying each effort to diminish the West's reliance on nuclear weapons has been a cry for a corresponding increase in NATO's non-nuclear capabilities. The INF Treaty has proved no exception to this rule: although the Soviet Union will dismantle more nuclear missiles than will the United States, both presidential candidates have urged a buildup of conventional forces.

Many proposals emphasize super-sophisticated weapons and electronic devices based on so-called emerging technologies (E.T.). These systems include "smart" missiles and projectiles that can home in on targets, as well as advanced radars and sensors to pinpoint enemy locations. Development of such technology was a major recommendation of the U.S. Commission on Integrated Long-Term Strategy, a blue-ribbon panel assembled by the Pentagon and the National Security Council. "We must diversify and strengthen our ability to bring discriminating, non-nuclear forces to bear," the commission noted in its 1988 report, *Discriminate Deterrence*. "To this end, we and our allies need to exploit emerging technologies of precision, control, and intelligence that can provide our conventional forces with more selective and more effective capabilities."

Such initiatives should find particular favor with

HARD CHOICES

RAPID DEVELOPMENT OF HIGH-TECH WEAPONS WOULD DIVERT FUNDS FROM BASIC HARDWARE, INCLUDING THE APACHE HELICOPTER.



Dukakis, who has called for a "conventional defense initiative" aimed at "applying advanced technology to the challenge of fighting and winning a conventional war." However, the Army will argue for a stretched-out development of E.T. weapons, pushing their full-scale production into the distant future. The problem is that new high-tech weaponry will be expensive. To overcome advanced Soviet defenses, proposed E.T. weapons like the Army tactical missile system and the sense-and-destroy armament will need to be highly accurate—a capability that cannot be generated cheaply. Their rapid development and production would divert funds from such basic hardware as the M-1 Abrams tank, the M-2/M-3 Bradley fighting vehicle, and the AH-64 Apache helicopter.

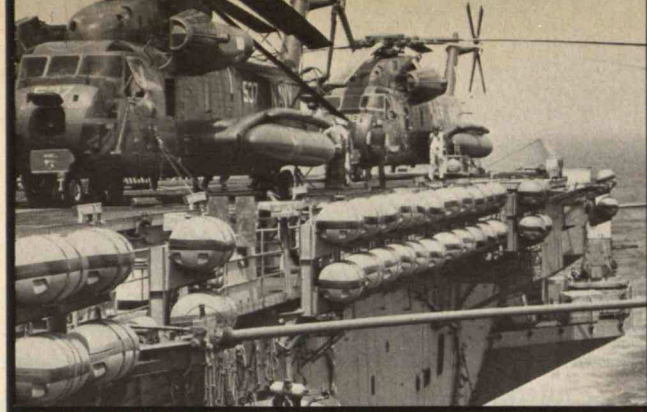
On the issue of getting other nations to share the defense burden, faster action is likely. With the large U.S. trade imbalance vis-à-vis Japan and Western Europe, Congress is increasingly anxious to redistribute defense tasks among the allies. Both presidential candidates have expressed support for such action.

Buttressed by this consensus, several members of Congress introduced amendments to the 1989 defense bill that would have reduced U.S. troop strength in Europe or otherwise pressured the allies into assuming a larger defense role. No punitive measures received a majority, but a "sense of Congress" motion calling for diplomatic pressure passed unanimously.

With a consensus but no firm action, the issue will command considerable attention in the year ahead, and any increases in Army spending will probably be linked to progress on it. "Equitable defense burden-sharing is a theme that must be addressed," Rep. Andy Ireland (R-Fla.) affirmed in March, "or the U.S. Congress is not likely to go along with any new plan for conventional-force increases."

Low-Intensity Conflict

Questions about the size of U.S. conventional forces, as well as about the probable nature of future threats to U.S. security, also arise in the increasing attention being paid to the doctrine of "low-intensity conflict" (LIC), or combat against guerrillas, terrorists, and other irregular forces. LIC operations were a marginal military responsibility after the U.S. defeat in Vietnam, but they have resurfaced as a major Pentagon concern in response to growing disorder in the



HARD CHOICES

BUSH WOULD CONTINUE THE CONSPICUOUS U.S. PRESENCE IN THE PERSIAN GULF, WHILE DUKAKIS HAS NOT RULED OUT MILITARY INTERVENTION IN REGIONAL STRIFE.

Third World. "LIC is one of the most serious challenges to our security that we face today," Carlucci has warned, "and our survival and well-being could depend on how we comprehend the threat and respond to it."

Such an appraisal does not suggest that any single incident is critical, but rather that the collective impact of many disorders and Third World insurgencies could damage U.S. security. The Commission on Integrated Long-Term Strategy has warned of "an adverse cumulative effect on U.S. access to critical regions, on American credibility among allies and friends, and on American self-confidence." Unless checked, this profusion of local conflicts "will gradually undermine America's ability to defend its interests in the most vital regions, such as the Persian Gulf, the Mediterranean, and the Western Pacific."

LIC strategists want a more active U.S. military posture in the Third World, plus a buildup of "power projection" forces—carrier battle groups and other forces configured for rapid insertion into distant conflicts. Carlucci has called for the continued expansion of these forces, particularly aircraft carriers, amphibious assault vessels, and long-range transport systems. He has also stressed revitalizing special-operations forces—the Army's Green Berets, the Navy's SEALs, the multi-service Delta Force, and other commando-type formations. Finally, suggesting that the primary effort in countering an insurgency must be borne by the affected government, he has proposed an increase in military aid to vulnerable Third World regimes.

These initiatives have encountered a mixed reception on Capitol Hill. Unquestionably, lawmakers want the Pentagon to conduct a more vigorous defense against terrorism and international drug smuggling. On the other hand, most shudder at anything that smacks of Vietnam-style intervention. Thus

Congress has resisted sharp increases in military aid to troubled Third World countries such as Honduras and the Philippines, and slowed procurement of the C-17, intended for long-range transport of bulky military hardware. With such conflicting impulses, lawmakers are unlikely to consistently support a significantly expanded military presence in the Third World, as is illustrated by periodic votes against direct U.S. military intervention in Central America.

Congressional ambivalence is mirrored in statements by the presidential candidates. While both Bush and Dukakis have called for vigorous efforts to protect U.S. citizens from terrorism, neither has been specific about the circumstances that would lead him to order troops into combat. Presumably, Bush would continue the sort of activities conducted by Reagan—strong support for the contras, military pressure on Col. Muamar Qaddafi of Libya, and a conspicuous naval presence in the Persian Gulf. Dukakis, for his part, has promised to bar military aid to the contras and seek international mediation of the Iran-Iraq conflict. But he has not ruled out military intervention in regional strife.

Fighters and Bombers

In contrast to the sharp debate over Army and Navy strategy, the Air Force faces largely a fiscal and technological quandary. For years, the pride of the U.S.

military has been its advanced fighters and bomber aircraft, and the choice here is between a shrinking Air Force and one composed of less-capable aircraft.

Superiority in this age of sophisticated electronics and exotic alloys carries a steep price tag. A new F-14 Tomcat fighter costs \$32 million, compared with \$9 million (in 1988 dollars) for a Vietnam-era F-4 Phantom. The advanced tactical fighter (ATF), a futuristic aircraft employing advanced electronics and "stealth" (radar-deflecting) materials, is expected to cost at least \$40 million each. Clearly, the Pentagon cannot purchase F-14s, let alone ATFs, at the same rate it acquired F-4s.

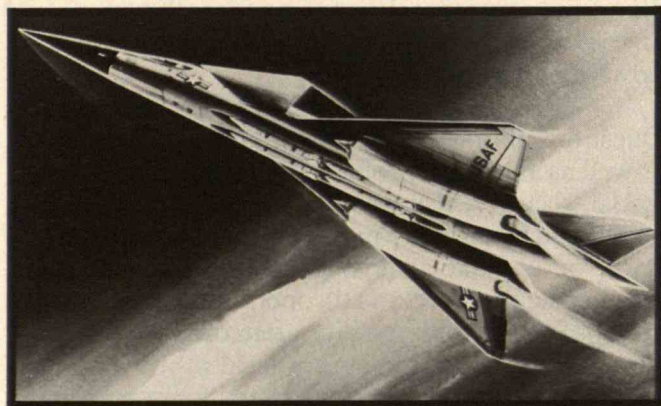
In 1988, Carlucci chose quality over quantity. The Air Force will lose one and a half tactical combat wings in 1989 (about 120 planes), and the Navy will lose one carrier wing. In addition, procurement of F-15 Eagle fighters will decline from 42 in FY 1988 to 30 in 1990. At the same time, the budget steps up ATF spending from \$489 million to \$702 million in 1989.

Although matters appear settled for this year, the next administration is left with a painful situation. If the Air Force proceeds to buy \$40 million planes, it will be impossible to avoid further reductions in operational strength. Despite cuts this year and next, the Air Force will have 35 tactical fighter wings, and an almost certain point of contention will be the prudence of returning to the 1980 level of 26 wings. Such a move would free enough resources to continue to develop the ATF but would diminish overall combat capacity. On the other hand, a decision to maintain current force levels would almost certainly require canceling the ATF and buying fewer numbers of existing aircraft.

The next administration will also have to wrestle with the thorny issue of the B-2 stealth bomber. Long heralded as the technological answer to Soviet air

HARD CHOICES

THE AIR FORCE MAY HAVE TO CHOOSE BETWEEN F-14S (LEFT) AT \$9 MILLION EACH AND ADVANCED TACTICAL FIGHTERS COSTING AT LEAST \$40 MILLION.





defenses, the radar-deflecting B-2 will be the costliest plane ever built—about \$500 million each. Proponents argue that the B-2 is needed to attack mobile Soviet missiles in the event of a prolonged nuclear conflict. Critics call that idea ludicrous: “The main weak point in the Pentagon’s plan is the idea that America, devastated by nuclear explosions and radioactive fallout, would be able to [use the B-2] to sustain a prolonged nuclear war,” Michael Brower of the Union of Concerned Scientists has argued in the *New York Times*.

Both candidates have supported R&D on stealth technology, but neither has committed himself to firm B-2 production schedules. “I support continued development of the stealth bomber,” Dukakis has hedged, “but a final decision on stealth production will depend on its affordability [and] on a careful assessment of whether the stealth can perform its mission effectively.” The “affordability” question will also confront Bush, whatever his preferences, so we can expect soul-searching on the B-2 no matter who goes to the White House in January.

Preserving the Empire

These are some of the most important issues facing Congress and the nation, but not the only ones. Indeed, the range of debate on defense and security policy is extraordinary. Some disarray is to be expected at the end of a period as dramatic as the Reagan era, but the current discord represents a deeper uncertainty—a fundamental questioning of principles that have governed defense policy for 40 years. For the first time, many policymakers are expressing serious doubts about such previously untouchable suppositions as the need for a large arsenal of offensive nuclear missiles, the maintenance of a large U.S. troop presence in NATO and South Korea, and the deployment of U.S. ships and combat forces in troubled Third World areas.

The questions arise amidst a perceived decline in U.S. power. Prompted by the stock-market crash, these anxieties have gained enormous impetus from Yale professor Paul Kennedy’s best-seller *The Rise and Fall of the Great Powers*. Drawing heavily on the histories of classic European empires, he argues that a great power declines when the costs of its overseas commitments exceed the capacity of its economic system. “As the relative economic strength of number-one countries has ebbed, the growing foreign challenges to their position have compelled

HARD CHOICES

THE NEXT PRESIDENT WILL HAVE TO WRESTLE WITH THE THORNY ISSUE OF THE B-2, WHICH WOULD BE THE COSTLIEST PLANE EVER BUILT.

them to allocate more and more of their resources in the military sector.” This has squeezed out productive investment and led to “a downward spiral of slower growth, heavier taxes, deepening domestic splits over spending priorities, and a weakening capacity to bear the burdens of defense.”

Kennedy’s observations “are circulating everywhere in Congress,” Sen. Timothy E. Wirth (D-Colo.) has observed. “They are referred to in hearings on and off the floor.” At Kennedy’s appearances on Capitol Hill, the questions have all circled around one concern: what can be done to allay the symptoms of decline. His consistent response: the United States must reduce its military expenditures or compel its allies to assume more of the burden.

Since Japan and the NATO countries appear as unlikely as the United States to increase defense spending, pruning military programs and commitments appears increasingly vital. Following a period of unprecedented affluence, this will prove especially painful for military leaders. In their frenzy to preserve favored weapons, service officials are likely to fight one another over every dollar in the diminishing pot. Rather than undergo a vicious internecine struggle, we should seize the opportunity to adopt a defense more in line with our needs and capabilities.

There are some who will argue that U.S. global responsibilities remain essentially unchanged, that we must preserve our existing forces even if it means scrimping in other areas. This is the preferred solution of the Commission on Long-Term Integrated Strategy. But the world has changed, and in some fundamental ways. Increased allied capabilities and a less threatening posture in Moscow mean the United States can devote more resources to other national needs—especially to revitalizing the sagging industrial infrastructure. The specifics of the shift will require close consultation between Congress and the next administration, but whatever the outcome in November, domestic and international realities favor such an approach. □



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SCHNEIDER
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DARK MATTER

The Search for the Invisible Universe

BY DAVID GRAHAM

FOR centuries, astronomers have assumed that the matter they can see in galaxies is the stuff of which the universe is made. And with good reason: the rest of space appears to be void, neither absorbing nor emitting light, heat, x-rays, radio waves, or microwaves. But, in fact, as much as 99 percent of all matter may be fundamentally different from the atoms that allow stars to shine.

According to recent surveys of hundreds of galaxies, what scientists commonly call dark matter might be generating ten times the gravitational force that stars alone could account for. This tremendous gravity is now thought to be responsible for the shape and rotational speed of spiral galaxies including the Milky Way.

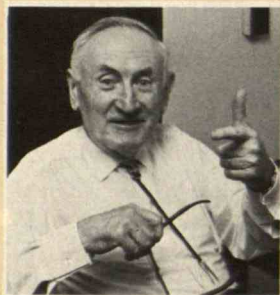
Scientists at the intersection of three disciplines—astronomy, physics, and cosmology—have proposed a variety of theories to explain the nature of dark

*Scientists agree that
most cosmic matter is missing.
Now they have to figure out
how to find it.*

matter. Some point to the possibility of stars too dim to detect with even the most powerful telescopes. Others speculate that a host of exotic infinitesimal particles known as WIMPS—"weakly interacting massive particles"—pervade the universe. Resolving the issue means devising a way to find and measure dark matter. This could elucidate several fundamental questions about the development of the universe, including how galaxies formed. What may emerge is a revolution in scientific thought on the same scale as the heliocentric model of Copernicus or the atomic model of quantum physics.

The Mystery of the Missing Mass

One of the first indications that some of the universe's mass might not be accounted for came in 1933, when astronomer Fritz Zwicky analyzed photographs of the Coma galaxy cluster. By measuring how the light from the galaxies in the cluster moved to the red end of the color spectrum—a stretching of the light's wavelength known as a Doppler shift—



IN 1933, CALTECH ASTRONOMER FRITZ ZWICKY FIRST PROPOSED THAT GALAXIES MIGHT BE SURROUNDED BY INVISIBLE MATTER.

Zwicky calculated that the galaxies were moving rapidly and should have been drifting farther and farther apart. Instead, they were swarming together under the influence of an unknown gravitational attraction much stronger than the mass of their stars could have generated. Zwicky boldly argued that the galaxies must be surrounded by some other kind of matter. But the cluster was so distant that many technical questions about his data cast doubt upon his theory. The subject of missing mass lay largely unexamined for the next

40 years.

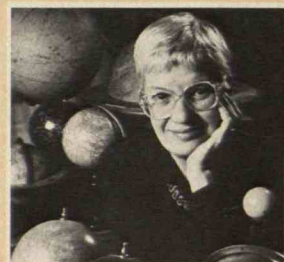
By the mid-1970s, better telescopes made astronomical observations far more reliable. And numerous studies of both individual galaxies and galaxy clusters suggested similar exaggerated gravitational

forces. Spiral galaxies like the Milky Way pose a simple example. Calculations using Newton's law of gravity predict that stars in the exterior arms should be moving more slowly than those in the body of the galaxy, since there are fewer stars in the arms and therefore less mass. However, in a study of over 150 galaxies, Vera Rubin of the Carnegie Institution in Washington discovered that the rotation of the outer stars is surprisingly fast. Estimates are that individual galaxies must have from 5 to 10 times the mass of their shining stars to account for the observed speed of rotation. The gravity in galaxy clusters indicates the presence of dark matter 10 to 20 times the mass of the visible matter. According to Princeton physicist Jeremiah Ostriker, spiral galaxies would collapse into bar shapes were there not a sphere of dark matter surrounding them.

From Proton to Grapefruit in 10^{-32} of a Second

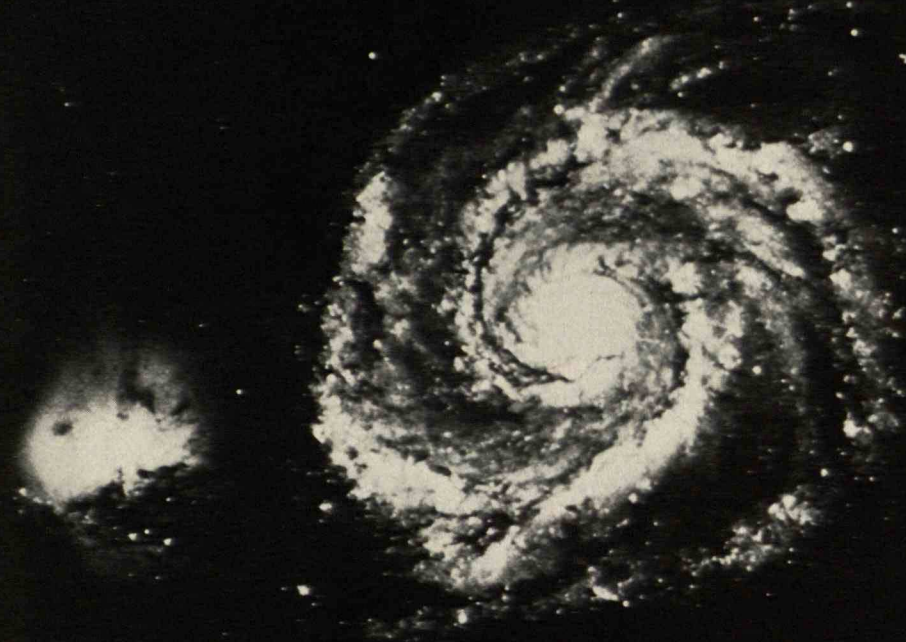
Some think dark matter might simply consist of stars too faint to be detected by existing telescopes. These cool, dim stars—so-called brown dwarfs, one-tenth to one-hundredth the mass of the Sun—might resemble the gaseous planet Jupiter. Enough of them dispersed throughout a galaxy could provide the extra mass necessary to generate observed gravitational forces. Yet about 1,000 of these stars would be necessary for each visible star—about 100 trillion per galaxy.

Another source of dark matter might be black holes, intense vortices of gravity from the collapse of massive hydrogen stars formed in the early universe. Black holes should be detectable, since matter drawn into their gravitational field would heat up and emit x-rays. But so far, extensive x-ray searches have not identified any black holes. While there is some evidence for about six possible candidates in our own galaxy, scientists estimate that billions would be necessary to account for the missing mass. What's more, popular new theories in particle physics and cosmology indicate the existence of dark mat-



IT WAS NOT UNTIL THE 1970S THAT ASTRONOMERS SUCH AS THE CARNEGIE INSTITUTION'S VERA RUBIN FOUND CONVINCING EVIDENCE OF EXCESS GRAVITATIONAL FORCES IN THE UNIVERSE.

DAVID GRAHAM is a science writer for the San Diego Union. He spent last year as a Knight Science Journalism Fellow at M.I.T., where he pursued a long-standing interest in theoretical and experimental issues in cosmology and particle physics.



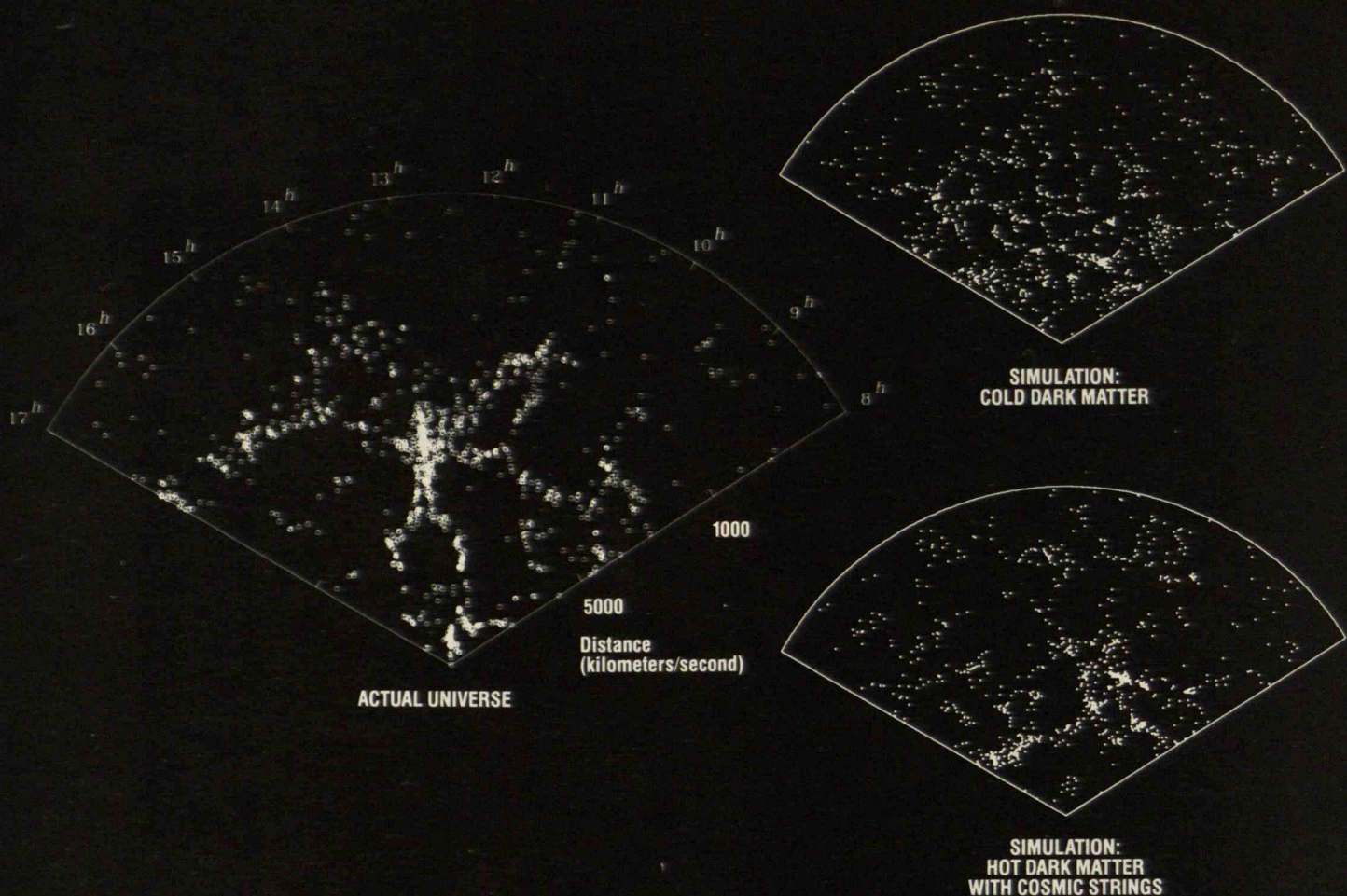
WHERE IS THE DARK MATTER?

Scientists' Leading Candidates

The stars in the exterior arms of spiral galaxies like the one above rotate faster than Newton's law of gravity predicts. This fact has led many scientists to believe that dark matter exists. Some physicists even argue that without dark matter, spiral galaxies would collapse into bar shapes.

CANDIDATE		DESCRIPTION	MASS AND PREDOMINANCE
Conventional atomic matter that could account for mass 10 times that of the visible stars:	Brown dwarf stars	Formed alongside the luminous stars, these dim stars, about the size of Jupiter, would not be massive enough for nuclear fusion to take place. Thus, their radiation would be too dim to detect with current telescopes.	100 trillion per galaxy, or 1,000 for each star.
	Black holes	These intense vortices of gravity resulted from the implosion of hydrogen stars ten times the mass of our Sun, which were the first stars formed in the universe. Scientists have identified only two good candidates for black holes in the Milky Way.	100 billion per galaxy.
Weakly interacting massive particles (WIMPs) that could account for mass 100 times that of the visible stars:	Neutrino	Known to exist; thought to have been created one second after the big bang.	Mass about 1/20,000 that of the electron; about 100 million per cubic meter of space.
	Axion	Predicted by theory, created 10^{-30} of a second after the big bang.	Mass about 10^{-10} that of the electron, the lightest of the WIMPs; 100 trillion per cubic meter of space.
	Supersymmetric	Predicted by theory, created 10^{-25} of a second after the big bang.	Mass about 5,000 times that of the electron, the heaviest of the WIMPs; one per cubic meter of space.



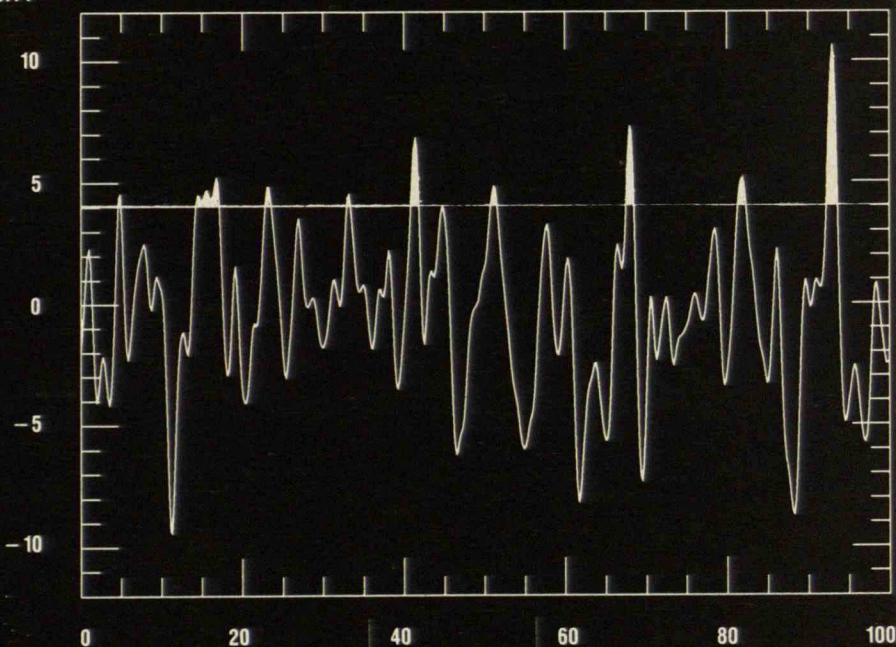


Above left: This map of 1065 galaxies in a portion of the universe suggests that they form around vast empty regions known as "voids."

Above right: These two smaller maps, produced by computer simulations, show how the universe would evolve according to two dark-matter scenarios of galaxy development. In both cases, galaxies cluster around voids much as they do in the actual universe.

Right: When galaxies formed, they represented only a small portion of cosmic matter—those points in the universe where matter was most dense. This graph plots density as it varies above and below the average across a given portion of the universe. The straight line represents the degree of density at which matter became visible.

DENSITY



DISTANCE IN MEGAPARSECS
(One megaparsec equals 3.26 million light years)



ter in quantities far greater than explanations about dim stars, black holes, or atomic matter in any form could ever provide.

In 1980, M.I.T. physicist Alan Guth proposed what has come to be called the inflationary theory of the early universe. It describes how the universe could have expanded from a size smaller than a single proton to that of a grapefruit in a fleeting 10^{-32} of a second. Guth's theory predicts that the universe, which continues to expand, has a "critical density" of matter, so that eventually it will slow almost to a halt under the influence of its own gravity. However, if Guth is right, then the universe would have to have 100 times more matter than meets the eye in galaxies.

By surveying the abundance of the simplest atomic elements—such as hydrogen, helium, and deuterium—present in stars now, other scientists have estimated how much of each of nature's elements must have been created in the big bang. According to these "nucleosynthesis" arguments, all the atomic matter ever made, dim stars and black holes included, would at most equal only about 10 percent of the matter that inflationary theory requires. And if all existing atoms are in the stars now visible to astronomers, then atomic matter could represent as little as 1 percent of the matter in the universe.

Enter WIMPs

At this time, only WIMPs can account for the excessive gravity in galaxies and provide the critical density predicted by inflationary theory. One type of WIMP, the neutrino, is known to exist; the rest remain theoretical constructs.

According to recent cosmological theory, WIMPs behave very differently from atoms. For one thing, they are virtually undetectable except for the gravitational force they exert on atoms. They also possess an extremely tiny mass—as little as several billion times smaller than that of the lightest known stable particle, the electron. Nevertheless, WIMPs may be present in such cosmic abundance to represent nearly all the matter in the universe.

Neutrinos were first produced one second into the big bang. They continue to be created by fusion reactions in the Sun and by the decay of certain radioactive elements. Unfortunately, the mass of the neutrino, if any, remains unknown. Various approaches to measuring it have proved inconclusive, because the neutrino's energies are so tiny and the margin of error in measurement so great.

Theories also predict two other kinds of WIMPs, both created in the first fraction of a second after the big bang. The existence of a particle called the

axion was proposed as a solution to a technical problem in quantum chromodynamic theory, which describes how quark particles interact to form protons and neutrons inside the atomic nucleus. Axions are the lightest WIMP, with a mass as tiny as one-ten-billionth that of the electron.

Another class of WIMPs arises from "supersymmetric" theories. These attempt to explain how the four forces of nature—gravity, electromagnetism, and the strong and weak nuclear forces—were united at creation. Supersymmetric theories predict that every particle of matter we can recognize was originally created with a supersymmetric particle partner. For example, a quark particle had a WIMP partner called a "squark"; a photon of light, a "photino"; a gluon, a "gluino"; and so on. According to these theories, most of the supersymmetric particles decayed soon after the big bang, with the possible exception of the photino, which may survive as dark matter. Supersymmetric particles would be the heaviest of the WIMPs, with a mass about 5,000 times that of the electron.

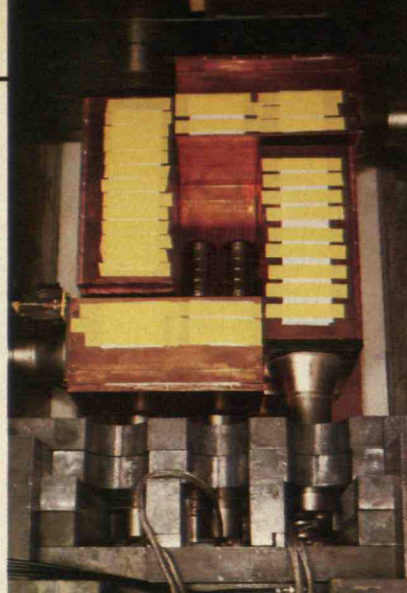
Physicists like WIMPs because they provide convenient explanations for several cosmological questions. Having identified the mass of a dark-matter particle, a team might calculate whether a universe filled with such particles would ever stop expanding. WIMPs may have so much mass that eventually the universe will collapse under its own gravity, or so little that it will expand forever.

Also, demonstrating the existence of these exotic particles could improve our understanding of how the galaxies were created. Conventional theories have relied upon gravity and atoms. They say that when the first atoms formed about three minutes after the big bang, atomic gases spread evenly throughout space except for tiny perturbations. Gravity supposedly pulled other atoms toward the perturbations where the gases were most dense, and such "clumping" continued until, billions of years later, the gases were so compressed that they heated

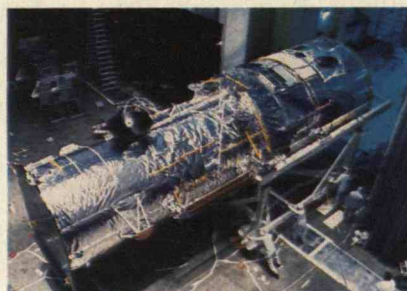


IN 1980, M.I.T. THEORETICAL PHYSICIST ALAN GUTH PROPOSED HIS INFLATIONARY THEORY OF THE UNIVERSE, WHICH REQUIRES DARK MATTER IN FAR LARGER QUANTITIES THAN ASTRONOMERS' CALCULATIONS HAD ORIGINALLY SUGGESTED.

This experimental device may allow physicists to observe an interaction between dark-matter particles and an atomic nucleus. Theoretically, such an event would produce ionization capable of being registered by detectors inside the two cylindrical objects at center.



The Hubble Space Telescope, to be launched on a future space shuttle mission, will help astronomers peer farther into space and perhaps learn how the first galaxies were formed.



up and became stars and galaxies.

But this explanation does not square with basic astronomical observations. In 1965, Arno Penzias and Robert W. Wilson discovered that the universe is filled with a smooth background radiation, measuring a steady -270.2°C , three degrees above absolute zero. The problem is that since the universe was so hot in the first 100,000 years after the big bang, atoms and radiation were coupled together, and clumping would have made the radiation in the regions of greater density even hotter, causing variations in the temperature of the background radiation today.

The contradiction between conventional models of the universe and the observations of Penzias and Wilson has led to new theories that place WIMPs at the very center of galactic development. WIMPs responding only to gravity may have coalesced during the first 100,000 years, independent of the action of radiation or atoms. Gravity would have exaggerated small perturbations in the homogeneous distribution of dark matter, and once atoms and radiation separated, the atoms would have fallen into the densest dark-matter regions. Under growing pressure over billions of years, the atoms would have lit up into stars and galaxies. The space around galaxies would have remained an apparent void, filled with a more diffuse distribution of dark matter and atomic gases, mostly hydrogen and helium. According to this view, galaxies can be considered illuminated points in the cosmos, like whitecaps on the sea of dark matter.

Scientists are debating two scenarios for precisely how galaxies might have lit up. The "cold dark matter" scenario involves slow-moving axions or supersymmetric particles, which would have formed galaxies first, then clusters and superclusters. The "hot dark matter" scenario involves neutrinos moving initially at nearly the speed of light, but slowing down as the universe expanded and cooled after the big bang. These neutrinos would have attracted atoms to form the largest structures, which then would have broken into individual galaxies.

Some theorists at the forefront of speculation have posited "cosmic strings" to explain how neutrinos might have slowed down enough to coalesce and attract atoms. Formed in the first fraction of a second of the universe, these infinitely long or looped bands of energy billions of times thinner than an atom would have held together the unified electromagnetic, strong, and weak forces of nature. Cosmic strings would have traveled at nearly the speed of light and exerted an enormous gravitational force, enough to get neutrinos to cluster together. Billions of years later, they would have radiated their energy as gravity waves and disappeared, leaving the neutrinos as dark matter around the galaxies.

Basement Astronomy

Astronomers and physicists are designing intricate experiments to coax individual WIMPs to interact with atoms and produce effects that are measurable in laboratories. If they can measure the energy transfer in a fleeting interaction between a WIMP and atomic matter, they might be able to determine the mass of a WIMP. This new way of studying the heavens is not restricted to the clear night sky. It can be done just as easily in the basement since, theoretically, WIMPs are everywhere.

A research team at the Brookhaven National Laboratory is testing whether an axion might convert to radiation, an idea first suggested by University of Florida physicist Pierre Sikivie. Led by University of Rochester physicist Adrian Melissinos, the team has surrounded eight 10-inch-wide copper cylinders with a strong magnetic field, hoping that some of the billions of axions in every cubic inch of the cavities will turn into energy detectable as microwaves. Since August 1986, a computer has scanned 5 million microwave frequencies for such an axion signal, but none has been found. The team plans to have checked 5 million more frequencies by year's end.

Other researchers are hoping that advanced technologies in solid state physics will make it possible to measure even the slightest movement or temperature change in materials cooled to near absolute

zero. University of California physicist Bernard Sadoulet plans to search for supersymmetric particles within small blocks of pure silicon or boron. He will supercool the material to within one-tenth of a degree of absolute zero (-273.2°C), a state in which



EXPERIMENTAL PHYSICISTS LIKE BERKELEY'S BERNARD SADOULET ARE LOOKING FOR "WEAKLY INTERACTING MASSIVE PARTICLES" OR WIMPS THAT MAY PROVIDE THE MASS CALLED FOR BY RECENT COSMOLOGICAL THEORIES.

an object has no heat. This might enable him to measure the vibration produced when a single particle hits an atomic nucleus. Since the mass of light elements like silicon and boron is closer to that anticipated for dark-matter particles, the effect of a collision might be more easily detected. However, it is extremely difficult to make reliable measures of small amounts of heat when working at such low temperature. Sadoulet's experimental design is still evolving, and it will probably be more than a year before his research is under way.

The proposed Superconducting Super Collider (SSC), a high-energy accelerator approximately 53 miles in circumference and made up of some 10,000 superconducting magnets, might offer another way to identify supersymmetric particles. Proton collisions in the SSC would yield temperatures and energies similar to those immediately after the creation of the universe. The collisions might even produce supersymmetric particles that theories predict and in a form that detectors could recognize.

Another class of experiments involves conventional telescopes for more careful observation of galaxies. Vanderbilt University physicists Thomas J. Weiler and Thomas Kephart have suggested that axions may decay to ultraviolet light, leaving a halo around galaxies. Such a halo might be visible through a telescope taken beyond the Earth's atmosphere.

Alternative Explanations

Despite physicists' enthusiasm for WIMPs, efforts to find them may prove futile. Current experiments may be too crude to detect the ghostly particles. Or WIMPs may not exist at all. And even if they do, some phy-

sicists, such as M.I.T.'s Guth, speculate that dark matter consists of some particle not yet recognized by cosmological theories.

Mordechai Milgrom, a physicist with the Weizmann Institute in Israel, mistrusts the basic understanding of gravity used in all the theories about dark matter. He argues that gravity may work differently across galactic distances than it does in standard Newtonian calculations. If so, scientists will have to revise the estimates of excess gravity that have so far been compelling evidence for the existence of dark matter.

Others dispute nucleosynthesis theories that require dark matter in the form of exotic non-atomic particles. They say that since more atomic matter could have been created in the big bang than current theories suggest, conventional atoms might account for the phenomena now attributed to dark matter.

Harvard University astronomer Margaret Geller, for one, questions the value of building models of the universe around particles for which there is no experimental evidence. Instead of chasing WIMPs, she argues for more powerful telescopes so that scientists might peer far enough into space to view light from the first galaxies and learn how they actually formed. The Hubble Space Telescope, to be launched on a shuttle mission, could help to do just this.

But right or wrong, WIMPs are the fashion guiding new theory. Part of the reason surely must be that if they are indeed the key to the nature of the universe's dark matter, then even more provocative questions may be within reach. For example, why do dark-matter particles and atomic matter exist in the ratio they do? Might the universe have been created without any atoms whatsoever? "In the end, we'd like to know if the universe could have been any different," says Yale University physicist Lawrence Krauss, "or if it had to be the way we see it today." □



SOME ASTRONOMERS LIKE HARVARD'S MARGARET GELLER QUESTION THE VALUE OF BUILDING ELABORATE MODELS OF THE UNIVERSE AROUND PARTICLES FOR WHICH THERE IS NO EXPERIMENTAL EVIDENCE.



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Engineering the Environment

Restoring the Earth
by John J. Berger
Doubleday/Delacorte, \$9.95

Playing God in Yellowstone
by Alston Chase
Harcourt Brace Jovanovich, \$10.95

Reviewed by Daniel Grossman

The art of imitating nature has recently become something of a fashion. Seattle's Woodland Park Zoo employs an approach it calls "landscape immersion" to create the illusion of wilderness for its visitors. Biologists at the Smithsonian's Marine Systems Laboratory are artificially constructing live coral reefs. Biologist Daniel Janzen is recreating a tropical forest in Costa Rica's Guanacaste National Park. Books, journals, consulting firms, and conferences are promoting "environmental restoration" to reclaim damaged urban and rural habitats.

At first glance, the impetus behind such efforts seems obvious. After centuries of polluting the air and water and destroying nature, we are finally attempting to restore parts of the environment to their natural state. But do such efforts really accomplish what their proponents think? As two recent books suggest—sometimes wittingly, sometimes not—the artificial recreation of "natural" environments is beset by an inherent contradiction. The problem with trying to imitate nature is that often we end up imitating only ourselves.

Destroying the Wetland to Save It

According to John J. Berger, our environment is sick, but appropriate human intervention can cure it. Berger criticizes mainstream environmentalists for putting their efforts into protecting threatened ecosystems after it is too late to save them. As an alternative, he recommends focusing on habitats in which the damage has already been done and returning them to their original state. *Restoring the Earth: How Americans Are Working to Renew Our Damaged Planet* recounts how individuals, organizations, and communities have restored some cherished natural resources—a dead lake, a river-turned-swamp, a marsh, a hazardous waste site,



even a suburb—through sheer gumption.

Typical is the successful crusade of Marion R. Stoddart, a resident of Groton, Mass., to reclaim the local Nashua River. By making the condition of the Nashua a political issue, she was able to recruit local, state, and federal officials—even the army commander of nearby Fort Devens—to her cause. As a result, the state raised the water-quality standards for the river, requiring more extensive treatment of effluents. The town of Fitchburg, a major source of pollution, built a waste treatment plant. And with the help of state funds, Stoddart implemented a plan she had devised to grace the river banks with pleasing "greenways" or undeveloped parkland. What was once one of the dirtiest rivers in the nation, says Berger, became "an aesthetic and economic asset to the region."

Such a success is certainly admirable, but the image of nature that seems to lie behind Berger's cases is peculiar. Many of his examples suggest that the role of nature should be to please; he defines a "natural" environment as one that is appealing to human senses. Thus the Quashnet River, restored by an organization called Trout Unlimited, now has "banks [that] are firm and well defined," shores "covered by three-foot-high canary grass," and a streambed "filled with swiftly flowing deep water . . . [where] the silt and organic debris have been washed off the bottom." The serious angler's dream!

If nature is primarily a screen on which

to project our ideas of the aesthetically pleasing or a stage on which to perform recreation activities, then human-made environments probably are as good as any. Cleverly constructed theme parks can easily substitute for environments not of human design. However, in some cases restoration may actually contribute to the destruction of what little pristine land remains.

Consider the case of Edward Garbisch, a chemist dedicated to recreating saltwater marshes, who makes an appearance in Berger's book. Marshes are an extremely fertile habitat supporting magnificent populations of waterfowl, fish, and plants. Unfortunately, about half our coastal wetlands have been destroyed. Garbisch has discovered how to create a living marsh by sculpting the earth into the ideal substrate and planting marsh seedlings into shifting tidal waters.

Thanks to a federal law requiring developers who destroy wetlands to rebuild them somewhere else, his skills are much in demand. "Rerouting a pipeline fifty miles around a wetland could cost millions of dollars," explains Garbisch. He can build a new marsh for much less. But in the process, he substitutes an artificial wetland for a truly natural one.

Even if these habitats survive the test of time, they replace the complex organic interdependencies of natural marshes with what Garbisch elsewhere has called "functional values" that maximize "pre-established attributes." In fact, Garbisch himself has admitted that "it's a waste of time to say that a constructed wetland will be identical to a natural wetland."

From One Extreme to the Other

In *Playing God in Yellowstone: The Destruction of America's First National Park*, Alston Chase provides a fascinating example of how human attempts to create an imitation nature can end up distorting natural processes and destroying a natural environment.

Exposing nearly a century of U.S. Park Service mismanagement of Yellowstone, Chase maintains that the park is in serious danger of ecological collapse. Predators such as wolves, cougars, and coyotes were exterminated long ago. Lacking natural enemies, the elk population has grown out of control and is scouring the park for food. Deer, who can't compete with hungry elk, are nearly gone. The elk have de-

Recreating nature
often just means indulging our own ideas
about it.

voured aspen shoots, the sole source of nitrogen for wintering beavers—which are also disappearing. The list of endangered animals in Yellowstone includes long-horn sheep, moose, antelope, and grizzly and black bears.

The root of the catastrophe, Chase shows, lies with the policies of the Park Service, a descendant of the U.S. Cavalry. Though chartered to “conserve the scenery and the natural and historic objects,” as well as “provide for the enjoyment” of the park, the service historically concentrated mainly on attracting visitors. Tourists and the tourism industry that profits from them became the agency’s chief constituents in its yearly budget battle. Thus the service manufactured an ersatz nature designed to appeal to tourist sensibilities rather than any scientific notion of ecological integrity. For example, it actively promoted wildlife such as elk that attract tourists and discouraged—and, in some cases, even extirpated—wildlife such as grizzly bears and wolves that might harm



visitors or property.

More recently, Park Service policy has shifted from one extreme to the other. Embarrassed by an unpopular campaign to trim the elk population in the early 1960s, the agency began to advocate a policy of allowing parks such as Yellowstone that contained “intact ecosystems” to naturally regulate themselves. The plan called for humans to avoid interfering with the natural workings of the ecosystem to the greatest possible extent. The Park Service eliminated garbage dumps, a popular feeding area for bears; allowed forest fires to

burn unchecked; and left the elk population to regulate itself. While not disputing the theoretical desirability of leaving nature alone, Chase rightly points out that this too represents an all-too-human imposition on the natural environment. The fact is, the ecosystem of Yellowstone is simply no longer capable of maintaining its wildlife population without human assistance.

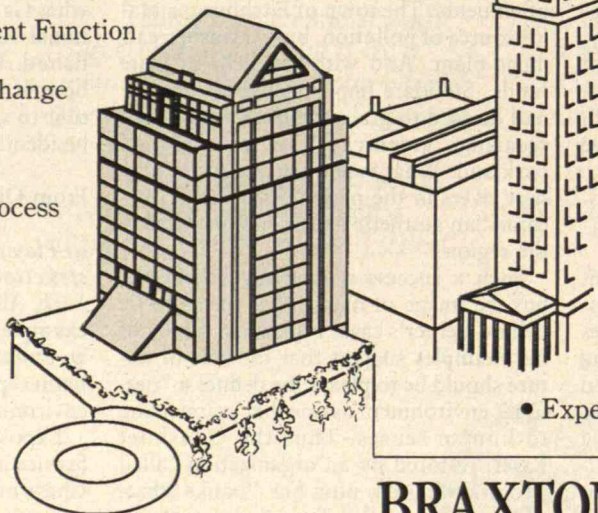
Through historical accounts, Chase demonstrates that much of the wildlife now occupying the park ranged over a considerably larger area before the arrival of white settlers. Elk and bears, for instance, probably spent only summers in the high altitudes of what is now Yellowstone and foraged elsewhere in other seasons. Natural predators checked the population of their prey. And Indian tribes also helped regulate the Yellowstone habitat; through hunting, they controlled the buffalo population and they periodically burned prairie to prevent forest growth.

Continued on page 74

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The railroad entered
American art as a toy-like machine in traditional
landscape painting.

Today, surrounded by cities and ranches, the park has become an island where wildlife is confined year round. The predators and the Indians are gone. Thus the park no longer has the necessary endowments to regulate its animal population. Left unmanaged in its "natural" state, it has begun to self-destruct. Chase takes the Park Service to task for failing to maintain the necessary scientific expertise even to monitor the devastating results of its faulty program.

In effect, Chase argues that some kind of human intervention in the natural environment is inevitable, and that we ought at least to be more self-conscious about it. He recommends a thorough study of the conditions that existed before settlers disturbed the vicinity of Yellowstone. Steps should then be taken accordingly to return animal populations to the natural carrying capacity of the land. Where necessary, human intervention would have to assist nature. For instance, bears might need extra food. Fires might have to be set to discourage forest growth. Finally, a research team must constantly monitor the health of the park ecosystem.

Nature in Our Own Image

This is certainly an improvement over the domesticated images of nature found in Berger's book. Given the pervasiveness of advanced industrial civilization, perhaps the judicious management of natural environments is the best we can hope for. We may live in an era where ecosystems need to be repaired and maintained by human hands so as not to be destroyed by them.

And yet there is something troubling about a view of nature as an entity to be managed or engineered. Untrammelled nature offers priceless gifts unavailable from even the best-managed "artificial" environments. Because untouched environments present us with intricately functioning worlds outside the flow of human history, they are a point of reference for assessing the worth of human experience. Human works, on the other hand, even those meant to imitate nature, are built in our own image. They merely echo our own desires.

DANIEL GROSSMAN writes on environmental and science policy issues for a variety of publications.



Technology in the Landscape

The Railroad in American Art
Edited by Susan Danly and Leo Marx
The M.I.T. Press, \$39.95

Reviewed by Rebecca Nemser

In 1841, Ralph Waldo Emerson urged the American artist to "employ the symbols in use in his day and nation to convey his enlarged sense to his fellow men." For many nineteenth-century American artists, the most powerful symbol of their time and place was the railroad. The epitome of vast impersonal energy, the railroad embodied the profound social and technological changes brought about by the Industrial Revolution. The poet Walt Whitman called it the "type of the modern—emblem of motion and power—pulse of the continent."

The 8 essays and more than 100 images in *The Railroad in American Art: Representations of Technological Change* examine the surprisingly frequent and forceful presence of the railroad in the work of a diverse group of nineteenth- and twentieth-century artists, including Thomas Cole, Asher Durand, Charles Sheeler, Arthur Dove, Edward Hopper, and Franz Kline. The book does more than just catalog the appearance of a particular technology in paintings and photographs;

it also provides a commentary on how art reflects and, at times, reconciles the often contradictory values of its time and place.

Landscapes of Reconciliation

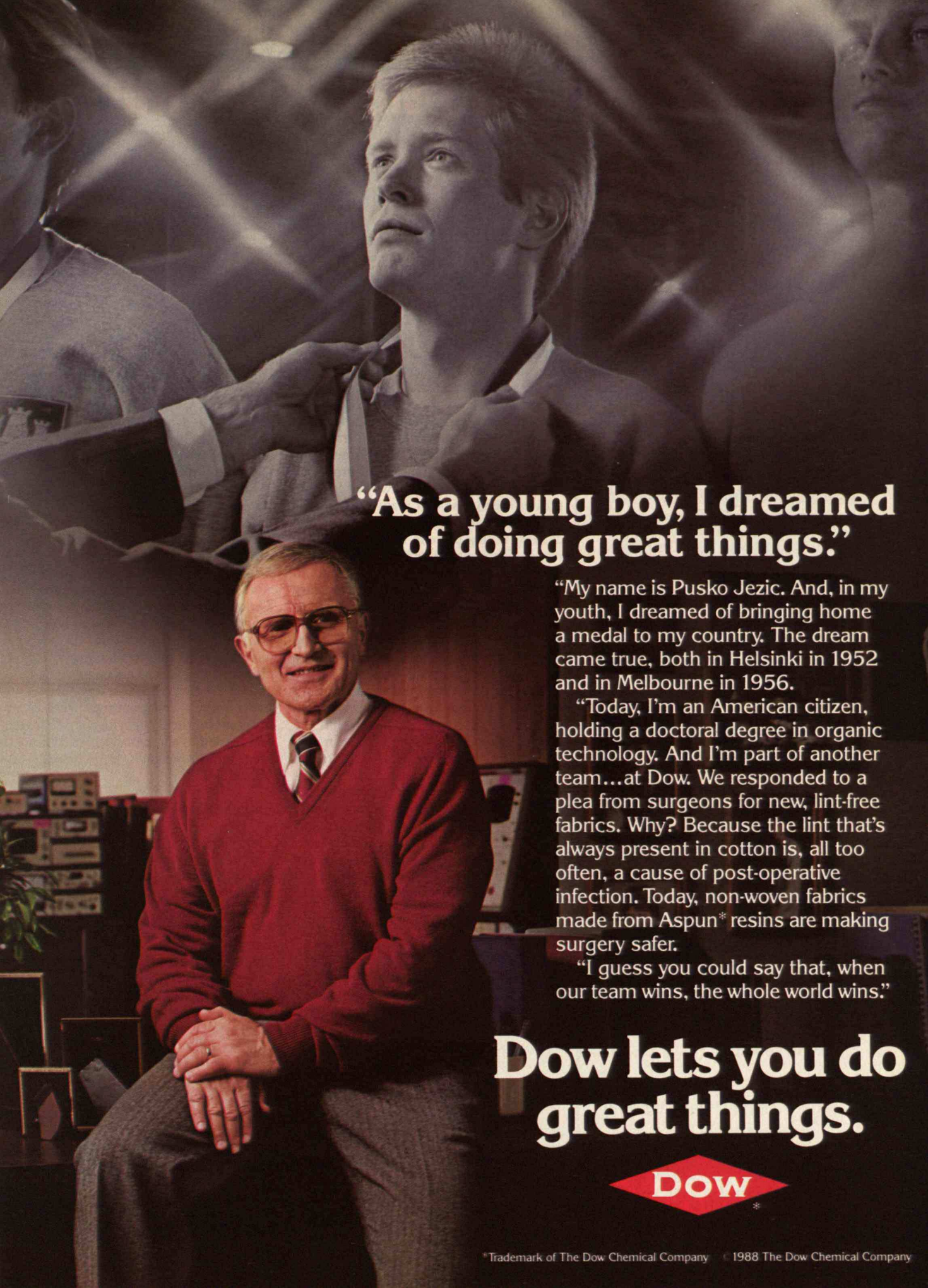
The construction of the first railroads in the 1830s coincided with the expansion of the American nation beyond its original boundaries. The railroad was an important tool for turning the wilderness into farms and farmland into cities, for clearing the forests, breaking through to the Pacific, and settling the West. And as business historian Alfred Chandler has pointed out, the railroad inaugurated a novel kind of business organization—the modern corporation.

Nevertheless, mid-nineteenth-century artists incorporated images of this revolutionary technology into thoroughly familiar aesthetic forms. Railroad trains first entered American art as tiny, almost toy-like machines in otherwise traditional landscape paintings, such as Thomas Cole's "River in the Catskills" (1843).

In this volume's concluding essay, M.I.T. cultural historian Leo Marx argues that this "railroad-in-the-landscape" represents a confrontation between the new urban-industrial order and a romantic ideal of the natural world. Rapid industrialization often brought environmental destruction and wrenching social dislocation. Yet painters and photographers used the visual language of the picturesque to assimilate the railroad into pastoral images of the American landscape. By depicting a harmony between nature and the new technology that was rarely present in reality, artists were expressing an emerging American ideal. Marx calls these images "landscapes of reconciliation."

Of course, many images from this period simply celebrate the railroad as a vehicle of territorial conquest and nation-building. As Susan Danley, curator at the Pennsylvania Academy of the Fine Arts, writes in the introductory essay, they make an "overt ideological statement." For example, in Andrew Melrose's painting "Westward the Star of Empire Takes Its Way; Near Council Bluffs, Iowa" (ca. 1865), the lamp of the onrushing train glows like a star illuminating a dark, wild land.

But other works capture some of the tension in the confrontation between nature and technology. Asher Durand's *Continued on page 76*



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BOOKS AND COMMENT



"Progress" (1853) is an example of a more complex "landscape of reconciliation." In the painting, three Native Americans watch from the woods as white settlers clear the valley below and fill it with farmland and canals, steamboats and towns. In the distance is the white steeple of a little church and a plume of soft white smoke from a faraway railroad train.

The presence of the Native Americans, visibly saddened by the toll of "progress" on their land and ancient way of life, expresses the unease that many mid-century Americans must have felt about the changes taking place in their society. And yet, as Danly points out, the inclusion of wilderness, farmland, and the railroad all in the same visual frame offers "the easy assimilation of new technological forms into the aesthetic mode of the picturesque." The composition of the painting resolves the ambivalence about change that its subject matter evokes.

The best of these nineteenth-century railroad paintings use the encounter between the traditional landscape and the new technology to communicate important truths about the industrial age. For example, George Inness's "The Lackawanna Valley" (1856) portrays not only a railroad train but also a roundhouse with its network of tracks. Together they constitute what Leo Marx calls a "technological system" representative of a new social order. The train blasting through the landscape at the center of the painting is an emblem of that more centralized, bureaucratic, and impersonal way of life.

For Marx, "The Lackawanna Valley" is the most fully realized expression of the "poignant dissonance" underlying America's industrial transformation. The painting communicates a sense of shock at these changes even as it celebrates the powerful and quintessentially modern beauty of the technological age.

Emblem of the Modern

Indeed, some of the writers in this volume suggest that for many artists, to paint the railroad was to ally themselves with the future in opposition to an idealized pastoral past. Nicolai Cikovsky, curator at the National Gallery, points out in his es-

say on "The Lackawanna Valley" that Inness deliberately chose to paint what the artist himself called "civilized landscape"—as opposed to pure wilderness—because it symbolized the modern.

Art historian Dominic Ricciotti sees another kind of landscape of reconciliation in the art of Charles Sheeler. The artist's "Rolling Power" (1939) is a close-up of the driving wheels of a locomotive that reveals the machine's cool formal beauty. For Ricciotti, Sheeler's sleek machine-age images of railroads in the new industrial landscape of the 1930s forge an abstract and more purely visual harmony between nature and technology.

Long after the railroad ceased to be a significant force in American history, it continued to appeal to American artists. No longer an emblem of the future, it became a symbol of a vanishing past. For Edward Hopper, trains and train stations were symbols of longing and yearning. Thomas Hart Benton called the railroad "the prime symbol of the adventurous life....The automobile and the airplane have not been able to take away from its old moving power as an assaulter of space and time." Even the abstract expressionist Franz Kline's first paintings were of the railroad in the Pennsylvania landscape, and he names some of his abstract works after famous engines like "Chief" and "Cardinal."

An Enlarged Sense of the Present

Clarifying the cultural significance of these and the dozens of other paintings and photographs in this book by no means diminishes them as works of art. By anchoring these diverse images in their social and historical context, *The Railroad in American Art* shows the power of art to express the deeper meanings of a particular place and time, even as it transcends those meanings to speak directly to the present. Furthermore, by showing us how men and women at the beginning of the age of technology made sense of their world and found a new kind of beauty in it, this book may help us develop an "enlarged sense" of our own technological culture.

REBECCA NEMSER is the art critic for WBUR-FM, a public radio station in Boston, Mass. Her article "Charles Sheeler: Master of the Industrial Sublime," appeared in the April 1988 issue of *Technology Review*.

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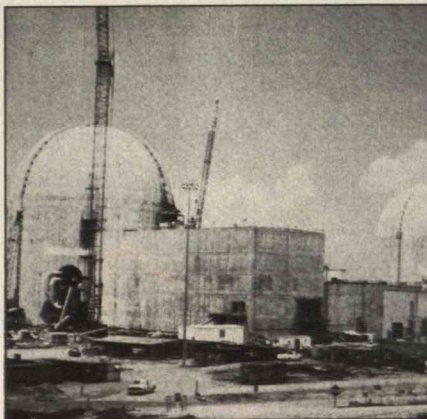
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safety violations at the South Texas Nuclear Project.

On the surface, the case seems to be a good one, but there is considerably more to the story. When GAP first announced it had the allegations from current and former project employees, the NRC and the utility sought details to correct those charges found valid. The NRC was skeptical, and with good reason. Since 1980, GAP has exposed "potential safety problems" at 47 nuclear power plants, nearly half the U.S. total. Requests for full-power licenses have been granted at all but three of the plants. In some instances licensing has been delayed by the need to investigate GAP's allegations; however, all but a very few have turned out to be unfounded.

For example, 740 allegations raised at a Midwest nuclear reactor were boiled down to 2—after a lengthy investigation by the NRC. And those had already been corrected by the utility. To avoid a repeat at the South Texas Nuclear Project, the NRC asked GAP for details at the outset. Only 1 of the more than 600 allegations was found valid and not previously addressed.

Missing entirely from "Court Victory for Whistle-Blowers" is any reference to GAP's dubious record for accuracy. Considering the source, this is not surprising. The article was written by an employee of a close political ally of GAP, the Environmental Action Foundation (EAF). EAF and GAP, together with several other groups, aim to halt the licensing of commercial nuclear power plants, destroy public confidence in the NRC, and create maximum doubt about nuclear safety. None of these organizations has the slightest interest in nuclear safety.

The right of these organizations to pur-

sue their agenda is unassailable. For them to support one another's programs with published articles is in keeping with well-established political tradition. But for a respected publication to print their biased, self-serving accounts in pages ostensibly devoted to news is simply bad editorial judgment.

J.R. WARGO
 Washington, D.C.

J.R. Wargo is managing editor of Nuclear Industry, a publication representing utilities.

SOFTWARE PRICES AND PIRACY

In stating that "widespread copying is one factor in high software prices," Anne Branscomb is putting the cart before the horse (*"Who Owns Creativity?" May/June 1988*). In fact, high software prices are the major cause of widespread copying.

More than 90 percent of the purchase price of a literary work covers production and distribution costs, while less than 10 percent goes to the author. These proportions are usually reversed for personal-computer software. It is only because software producers insist on receiving such hefty profit margins that copying has become commonplace.

Book publishers do not have a significant problem with people xeroxing rather than purchasing books. If Lotus Development Corp. were content to charge the same price for 1-2-3 as a publisher charges for a Steven King novel, Lotus wouldn't have a copying problem, either.

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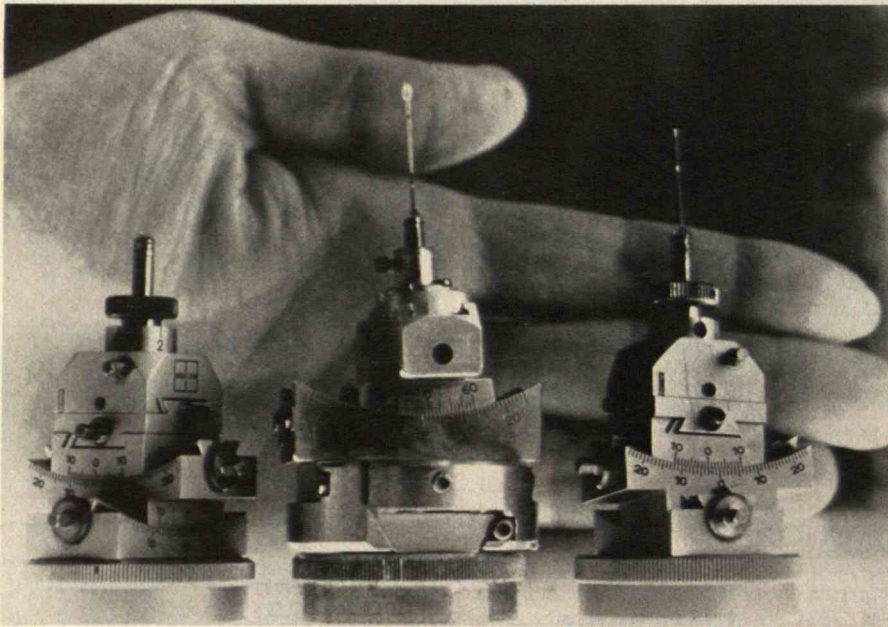
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What Happens When the Second Engine Quits?

For the pioneers of intercontinental commercial flights, aircraft with three or four engines seemed de rigueur. If one engine failed hundreds or thousands of miles at sea, two or three would survive to power the plane to a landfall.

With the advent of jets—and especially the Boeing 767—this safeguard seems to have lost urgency. Transoceanic ETOPS (extended-range twin-engine operations) were first flown in the South Pacific in 1980 and now are routine on many flights crossing the North Atlantic and Indian oceans.

How likely is the mid-ocean scenario that leaves a two-engine plane first with one engine and then, after a second failure, with no power at all? And how likely is such an event to cause loss of the plane and some or all of its passengers?

No one knows. After six years of ETOPS, it hasn't happened yet, and the theoretical calculations are complex—many variables, including wind and weather as well as geography.

Analyzing the issue, Robert W. Simpson and Raymond A. Ausrotas of M.I.T.'s Flight Transportation Laboratory urge care. There are several weaknesses in ETOPS procedures, they say:

- ☐ As over-water ETOPS flights increase,

This image of three x-ray crystallography mounts used in DNA molecule research at M.I.T. is one of 86 photographs in an exhibit entitled "Three on Technology," shown at M.I.T.'s List Visual Arts Center last spring. Commissioned by the M.I.T. Committee on the Visual Arts, the work of photographers Robert Cumming, Lee Friedlander, and Jan Groover presents some highly personal images of contemporary technology and the people who work with it. "Three on Technology" is currently on exhibit at the University Art Museum at California State University in Long Beach. It will also travel to the Virginia Museum of Fine Arts in Richmond and the Grand Rapids Art Museum in Michigan.

there's a risk that both airlines and regulators will become too casual.

- ☐ A technical inconsistency needs correction, say Simpson and Ausrotas: "The current ETOPS rules do not limit routes to 120 minutes' flying time from a suitable airport, although many of the guidelines... assume this [rule to be in place]."

☐ Many questions about risk and its assessment remain unanswered. For example, is the chance that a second engine will fail greater when a first engine has already failed?

- ☐ Actual tests of two-engine aircraft cruising long distances on only one engine are not now required, though some air-

lines conduct them. Simulator tests are no substitute, say Simpson and Ausrotas. "It seems odd that the traveling public may be aboard when approved diversionary procedures are actually flown for the first time," they write.

How Japan Wins at Automotive R&D

Compared with Japan, automotive research and development in the United States is grossly inefficient. Despite an investment that is substantially smaller than ours, Japanese automotive R&D wins the race:

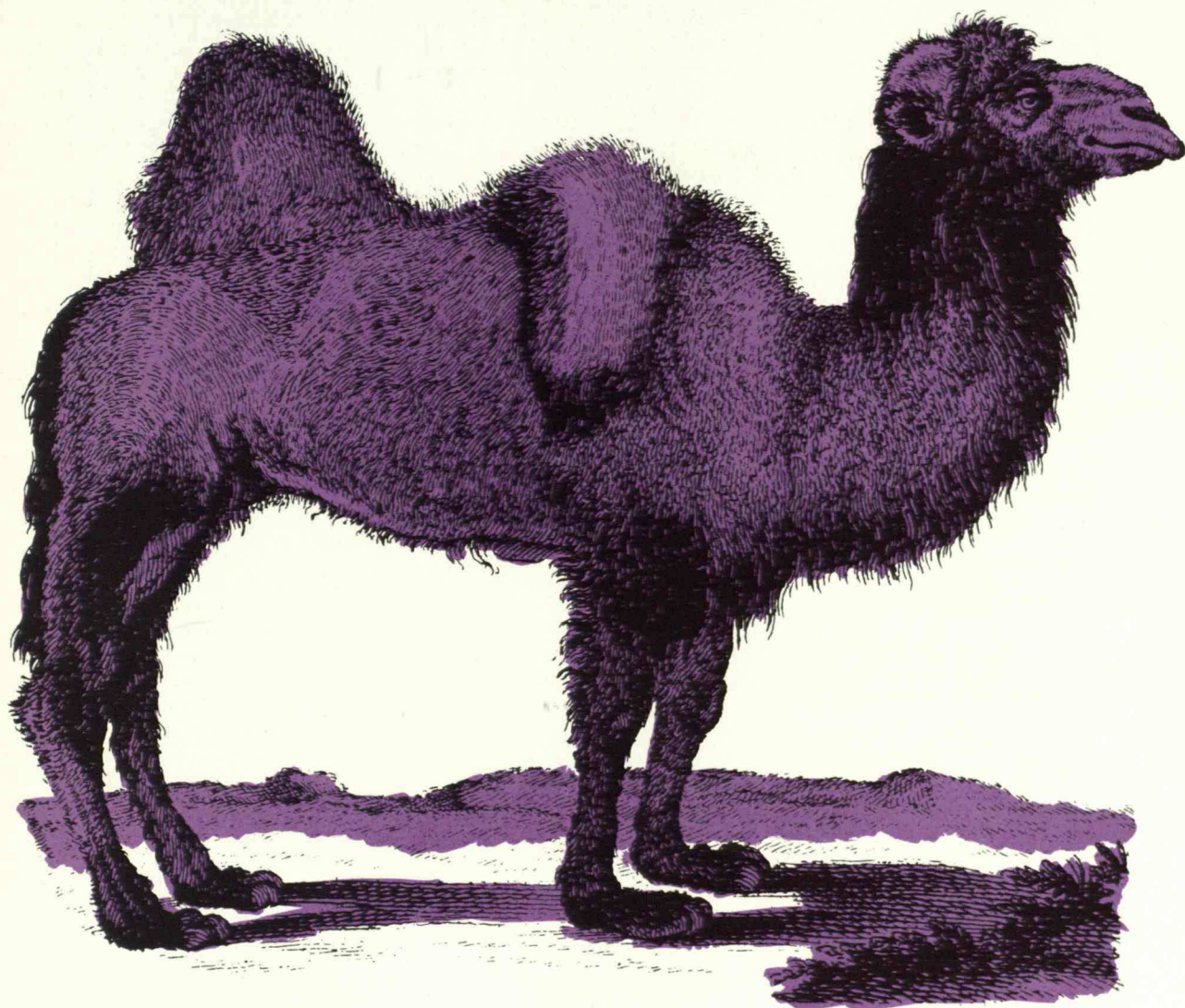
- ☐ It produces more patents.
- ☐ Its results reach showrooms more quickly.
- ☐ It has actually overturned the balance of international technology transfer since 1980: the Japanese are now sending more new automotive technology—multivalve engines, electronic transmissions, and computerized control systems, for example—to the U.S. than we are sending to them.

The difference, says Andrew Graves of the University of Sussex in a report for M.I.T.'s international motor vehicle research program, is fundamental: R&D is ubiquitous in Japanese automaking. It plays "a core role within the overall company structure," says Graves. There is close and constant interaction between R&D, marketing, and production. By the time it finally reaches the assembly line, an innovation is fully proved and understood. The shop floor, having been closely involved in the development process, knows all about it.

In contrast to the United States, highly trained engineers are assigned by Japanese automakers throughout the system—R&D, testing, manufacturing, and assembly. "They enjoy a more 'organic' relationship to the technology," Graves says, the result of "a fundamentally different type of social organization and professional development."

As a Japanese executive told Graves during his research, "In Japan workers are seen as the solution to problems while in the U.S. workers are too often seen as the problem." And if this system works better now, it will work even better in the future, warns Graves, as increasingly sophisticated technologies make their way into automobiles.

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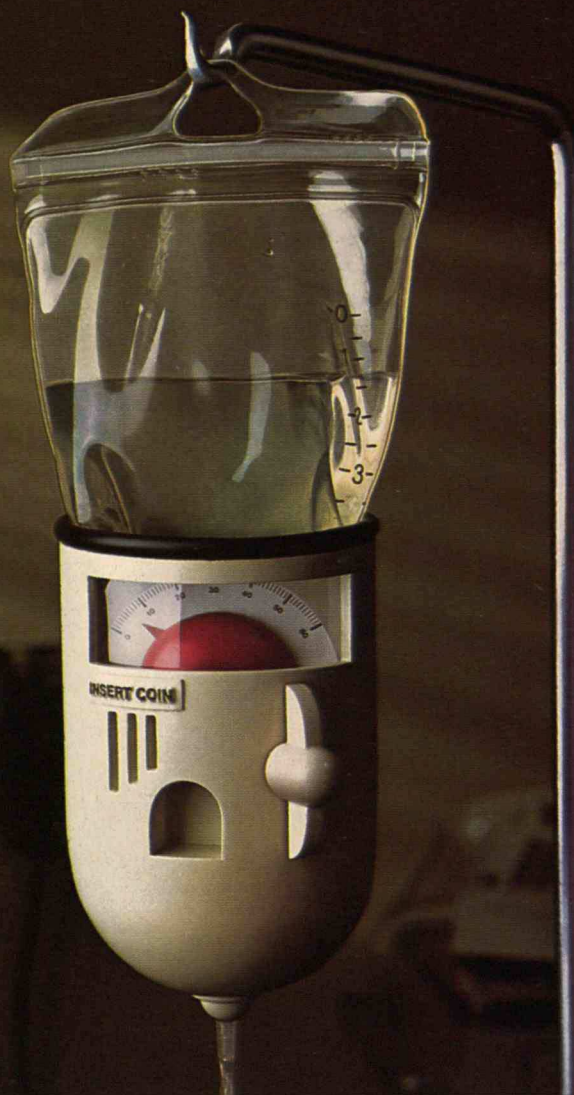
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